Proceedings from a series of regional seminars on microelectronics in the wood products industry.

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present

Microelectronics in the Future of the Coastal Sawmill Industry

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Foreword

The following proceedings relate to a seminar entitled Microelectronics in The Future of the Coastal Sawmill Industry presented in Vancouver, British Columbia on February 23, 1984. The seminar was the last of four regional seminars on the same theme, which were presented at various locations in western Canada. The preceding seminars were held in Jasper, Prince George and Kelowna. Financial support for the seminar was from the federal Department of Regional Industrial Expansion.

Forintek Canada Corp. wishes to acknowledge the federal government contribution and the role of the Council of Forest Industries as co-host of the seminar.

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Opening Remarks

Tony French
President and CEO, Forintek Canada Corp., Vancouver, B.C.

Forintek is pleased to have had the opportunity to present a series of seminars across Canada this winter to draw attention to the advantages of using microelectronics to improve sawmill productivity. Today we present the last in the series of eight seminars which have included about 800 people in total and have taken us to Prince George, Kelowna, Jasper, Timmins, Ottawa, Quebec City and Moncton.

Each seminar has been presented with the full support and co-operation of the regional lumber associations. Today we greatly appreciate the suport from COFI and its staff.

The seminars have been financed by the federal Industrial Regional Development Program which is administered by DRIE. Part of the cost will be for the preparation of a book of proceedings that will contain all of the presentation and discussions from this seminar.

The purpose of today's seminar is to create an environment among the participants to explore some of the issues of technological change. We must concern ourselves with labor and training matters, the selection of economically viable technologies, capital investment and the competitiveness internationally of our wood products industry. The last speaker will introduce you to a word that is rare in the lumber industry. The technology futurists are convinced that robotics has a role to play in our industry. There is already a substantial investment coming into place in this province that will stimulate progress towards the understanding and use of robotics in the future. I am referring to the new Centre for Advance Resource Technology at Prince George. So it is not too early now to begin to address some of the issues that will inevitably emerge over the coming months and years.

To set the stage for our program, Don Lanskail will give the opening address. Don is president and CEO of the Council of Forest Industries of B.C. It is very appropriate that COFI start our discussion today because the COFI activities nationally and internationally provide an excellent basis to identify the challenges that our coast industry must face to remain competitive in future international markets.

* * *

Opening Address

Don Lanskail
President & Chief Executive Officer
Council of Forest Industries, British Columbia

My topic is the future of the coastal forest industry. Now that probably raises a great many more questions than we are going to be able to discuss, but nevertheless examination of this topic is a very promising step in the correct direction.

We are becoming increasingly aware of the fact that the coastal forest industry is at the cross roads and some dramatic changes are necessary if we are going to retain our competitive position in the international market place.

I am sure that many of you will share the same experience that I have had in the industry. For many years, probably most of the years I have been in the industry, coastal mills have led the province in terms of production and sales. This strength was underscored by the popular image which still prevails in a large part, that coastal operators had an endless forest of old growth Douglas-fir and cedar in the various timber farms, as tree farm licences and TSA's to which they had access. While those in the tourist industry may try to perpetuate the idea of an endless Cathedral Grove all through British Columbia, we in the industry are faced with different realities.

The first of these realities is that in the late 1970's the value of coastal production fell behind that of the interior for the first time. There are, of course, many reasons for the higher delivered log costs, including the variety of species and log sizes that characterizes the coast compared to the interior and those species that have to be processed in mills with a diminishing supply of those coastal giants. This problem is compounded by the fact that many of our production facilities are definitely in the 'senior citizen' category unfortunately without the benefit of government pensions or something equivalent to that.

The second reality is that the coastal operators, while fully aware that some of their plants are outmoded and inefficient, cannot just dismantle these mills and start from scratch. That obviously is economically impossible. They are faced with the task of redesigning and retooling operations while still maintaining steady cutting schedules.

The third factor is perhaps the most frustrating for all concerned, and stated in the most simple terms boils down to one statement an absence of money. I don't have to draw attention to the red ink that has characterized the industry, particularly the coastal industry, through 1981, 1982 and 1983 for that matter. Coastal forest companies are only too aware of what is needed in the way of upgrading existing facilities and constructing new ones. But until the debt loads reach manageable levels, capital expenditures by necessity have to be kept to a minimum.

Now let me describe the scenario which places the coastal forest industry somewhere between the proverbial rock and the hard place. Let me be quick to say that a number of actions can, and are, being taken to ensure that coastal mills produce top quality products which can be offered at competitive prices in the international market place. That of course is the bottom line, maintaining and, wherever possible improving, the market share of British Columbia lumber in offshore markets.

While this may be old hat to many, I think it bears repeating. Forest companies on the B.C. coast have a major problem in the high cost of logs. For every $50 that the coastal mills have to pay for logs, the interior equivalent is about $22, or less than half of the log cost. And our competitors in the U.S., both in the Pacific Northwest and the U.S. south, have a relative cost of about $45. So the coastal mills are at a serious disadvantage even before the log meets the saw blade. And this means that production costs and quality must be tightly controlled if they hope to maintain a competitive position by making up that disadvantage in terms of log costs.

Now what is the answer? It is clear that the coastal sawmills must be efficient and cost-effective in terms of their facilities and production processes. If the way of the future is through advancing technology, and I think most of us have to admit that is correct, then the key for our industry is in the use of microelectronics. The fact that the tiny silicon chips can hold the knowledge necessary to control intregated cutting patterns still boggles the minds of many in the industry, including myself. Not only will these bits of mineral streamline mill operations, they will cause us to re-think our entire approach to lumber production. Integrated information systems will require us to look at the whole process, rather than at the component parts.

An immediate positive result of this total view occurs in the area of quality control. A decade ago, it was common for coastal mills to ship rough green lumber with size tolerances of one-eighth inch undersize and one-quarter inch oversize. Today our major markets demand a higher standard of uniformity to the point that even one millimeter of variance is frowned upon. Precision on this scale cannot be achieved using 50-year-old equipment, and this is where microelectronics can pave the way. Research of the kind that is done by Forintek has proven that technical changes in processing methods will result in less waste at the users' end, making our products more desirable and therefore more valuable in the market place.

Not only will the industry have to move into the realm of hi-tech to ensure increased efficiency and productivity, it will also have to enhance the image of species that have been traditionally in the 'also ran' category. In this I am thinking particularly of hemlock, which has always been seen as the poor relation of coast Douglas-fir and cedar. In recent years, hemlock producers have applied the value added concept to this plentiful wood with the result that new end users have become convinced of its value. The wood products division of COFI has been active in the promotion of hemlock as a quality wood for door and ladder stock, window frames and special applications in countries such as Japan which favor light colored woods. A recently completed COFI film entitled "The Natural Choice" is intended to show architects and builders how hemlock can meet their needs.

I would like to share a concern that I have related to the rush to new technology. In this I might be taking a step in the same direction as another speaker at this seminar Bob Blanchard from the IWA. In our eagerness to embrace all that is new and exciting we should not overlook the apprehensions of forestry industry workers. Their primary need is to know that human hands and minds will continue to be the most valued tools of the industry. Employees on the mill floor, and those in executive offices as well, feel a common level of uncertainty about how new techniques will affect their jobs. It is a well-recognized quirk of human nature that we tend to fear those things that we do not fully understand. If the same perceived threat enters our homes and our places of work almost simultaneoulsy, anxiety levels skyrocket. When young people speak with confidence about bits and bytes and modems, they can all get to be too much for the parent who is worried about his or her job, how it will be drastically changed or lost all together, as a result of these new electronic marvels.

Clearly we face a multi-horn dilemma and I would like to leave you with the questions tacked onto those horns. First of all, how can the coastal forest industry utilize modern technology to renew its operations? Secondly, how can we change customer attitudes about products that have earned poor reputations in the past? Third, how can we reduce the anxiety among forest industry workers about incoming technology and involve them in the planning and implementation processes? Four, how can the coastal forest industry upgrade existing operations and plan new development at a time when capital expenditures are strictly curtailed?

It is in this light that I congratulate the organizers of this very important seminar and also those who are in attendance. It is this kind of action and program that is going to help ensure what I think is possible, and that is a bright future for the coastal forest industry. And in that light I would also congratulate MacMillan Bloedel, the largest company in the industry, on their vote of confidence, which was announced recently in the construction of a new mill at Chemainus. That augurs well for the future of the coastal forest industry if we really come to grips with the challenges and do what is necessary to ensure that bright future.

* * *

Coping With Microelectronics: The Labor Viewpoint

Bob Blanchard
First Vice-President, Regional Council Number One
International Woodworkers of America, AFL-CIO-CLC, Vancouver, B.C.

I am making this presentation as a result of a request from Ray Clarke, associate director of Forintek, to the International Woodworkers of America to have labor's views expressed at this seminar. I am happy to say that the IWA is proud of the fact that we involve ourselves in other areas than the adversary role that is being played and believe that labor has a part to play in all other aspects of industry.

For nine months we played our traditional role of the adversaries at the bargining table. Everyone here is aware of the present state of the forest industry. I am not talking about microelectronics, automation or technological change, or whatever the coin phrase may be for the subject matter I have been asked to address. I am referring to the settlement reached by the IWA and wood sector employers and the subsequent lockout by pulp employers of their CPU and PPWC member employees. It is apparent that the IWA has become an injured, innocent third party to what is fast becoming a battle of who can paint themselves into a corner the fastest.

As a result of the actions taking place in the forest industry today, I have had to amend my text somewhat. I was going to mention that since our IWA role as bargaining table adversaries was over for the next few months, we could explore those areas that are of mutual concern to both management and union. It is now becoming apparent that working together to resolve common concerns may be put on hold for an indefinite period of time while we wait for a solution to the pulp dispute. There is little doubt that the longer the stalemate continues, the more our membership will be hurt.

However, in spite of present problems, these kind of seminars are beginning to indicate that, although we have an adversarial role to play, we can at times also work together to resolve common problems. The case in point is the agreement reached by both parties in our negotiations to structure a joint high-level committee to attempt to resolve the productivity factor in logging. I want to preface my remarks by stating that most of my experience in the forest industry has been in coastal operations. There has been very little opportunity to see the effects of technological change in that area. I think Mr. Lanskail underlined that most of our coastal operations should have been pensioned off years ago.

Having addressed two previous Forintek seminars in the interior, I understand they are a little more involved in microelectronics there than here on the coast. Let me state quite clearly that the opinions I express are not necessarily views and opinions shared by the entire labor movement. In actual fact, I would venture to say that IWA's philosophy towards the introduction of technological change differs considerably with other labor bodies, be they public or private sector unions. The IWA has traditionally supported the need for modernization. The truth is, we have publicly admonished the forest industry in B.C. for their lack-lustre performance in updating their operations. In actual fact you could say we have made a career in doing just that. This unfortunate tardiness and I use the word loosely in updating their operations has created a legitimate and growing concern for us. A slow and steady or partial introduction of technological change within the industry would have allowed the transition to take place with little or no job loss as a direct result of computerization. The decrease, if any, in jobs and membership would have been absorbed through natural attrition.

The ramifications of a complete and total changeover of an entire mill or mills cause untold consternation for the union, the employer, the

government, the economy, but first and foremost for the employees facing displacement, retraining or, even worse, unemployment.

Historically, employment growth in our industry has been slow relative to other sectors of the economy. For example, over the past four decades the significance of manufacturing employment has diminished substantially. In 1940 it accounted for approximately 40 per cent of all non-agricultural employment. By 1980 that figure had declined to only 22 per cent. The era of microelectronics will accelerate that trend.

Technological change is not, and I repeat **is not** creating jobs in our industry; it is creating employment in the hi-tech field. The only specific exception to that statement is in the trades categories. The ratio of trades people versus production workers has swung dramatically in favor of the maintenance personnel. The traditional skills of the trades person have had to be drastically revised to accommodate the introduction of computers.

The IWA, as I stated earlier, supported the introduction of modern production methods, but not for any sanctimonious reason. We were chiefly interested in the elimination of the onerous, tedious and backbreaking jobs in our industry. Unfortunately, the child in our eyes has become a monster. Technology is beginning to hurt the worker *per se*. The hi-tech syndrome now reaches out and attacks the skilled and semi-skilled as well as the laborer. The high wage earners, for example the sorters, have become attendants rather than operators.

We are on the horns of a dilemma. We recognize and support the need for change in order to survive in a competitive world market. But what good is survival if the right to retain an income is taken away from us as a result of modernization? The primary industry which the IWA represents had a membership high of approximately 58,000 in 1978 and 1979. We will be fortunate to maintain a level of 40,000 members in the coming year. And if the PPWC have their way, we won't even keep 40,000.

Now I don't expect everyone to shed many tears about the plight of the poor IWA. But I do expect some insight into what will happen if the potential consumer base shrinks even faster than productivity is spiralling.

I was a litte shocked to hear George Richards, general manager for Weldwood Interior Operations, say in his opening address to the Forintek conference in Prince George, that when he was down in Alabama, he toured a mill where he saw a bunch of robots with painted faces performing the everyday duties of displaced unions. That statement upset me greatly. I guess it was the way it came across, because it sounded like he was fairly proud of the fact that there was a bunch of robots replacing human beings. It's hard not to reflect on the Alabama incident George described. I don't think too many robots are going to need cars or televison sets. As producers they may have no peers, but as consumers they will be found wanting.

Employers and governments, even you and I, have an obligation to maintain the delicate balance between producer and consumer. Ideas that seemed unheard of 20 years ago, ideas that seemed radical or unrealistic today, must be explored, must be considered, and must be introduced or enacted. The present-day employer must undertake an extensive program of retraining. He must also give more than passing thought to guaranteed annual salaries, productivity sharing, or a workable form of job sharing. Governments must recognize the possibility of early retirement, bridging of pensions and drastic reduction to the work week as it presently exists.

More specifically to the forest industry, governments must release the millions of dollars needed for reforestation and silviculture. Failure to do so could hasten the demise of our industry at even a greater rate than it is today. You and I must set aside some of our traditional hangups and bug-a-boos and retool our thinking. We must learn to co-exist with the advent of the microelectronics generation. Maybe the agreement to establish a joint high level committee to explore logging productivity is a beginning of a more enlightened attitude toward our mutual problems and a more mature approach to labor's role. Those things that seemed absurd and preposterous a decade ago may be our only chance for survival today.

The forest industry's profile, especially on the coast, is going downhill. We must turn that around. They are losing their effectiveness on the economy and that is self-defeating. The large integrated companies must change their attitudes. They must become more aggressive in the area of export. Being solely dependent on one market is wrong in this age of computers. Industry must capture alternative markets such as Japan, China and the U.K. We have to improve our markets to be able to use our new-found technology so we can utilize those high cost, high quality trees, that are economically useless under today's production methods.

I could have gone into a long statistical dissertation on the effects of technological change on our industry. I could have given an example of the new versus the old, but what for. Suffice it for me to say that the leadership of the IWA understands the necessity for change, but we equally understand the need for a parallel program and a change in attitude designed to resolve the plight of the displaced or unemployed worker.

I would like to mention that I recently had the opportunity to tour Europe with a joint group of labor and management people to study industrial democracies roles there. Our union was preaching about having more worker's voice in the work place, while at the same time a number of management people were coming back from tours of Europe saying, "They sure have got utopia over there in Germany and Sweden."

We made a demand in negotiations that we have some industrial democracy introduced into our industry. And as a result of negotiations a joint committee was struck and we did go to Europe. The group was comprised of six union people thoroughly sold on the idea of industrial democracy, and six employers believing that there was only one form of industrial democracy, it was either the one they had been practicing over the last 50 years or the one that was being introduced, or had been introduced, in Europe.

We went to Europe to see what they had, six of us, and we all came back with the same collective thoughts. Some of the things they do over there, as far as industrial democracy goes, may well work in Europe, some of it may work in Canada, but the bottom line is that our systems are so different that to attempt to bring any program from a foreign country to Canada and make it work satisfactorily is totally impossible.

If we are going to develop programs in the field of industrial democracy or technological change, then we have to use the expertise within our country and most assuredly without the exclusion of specific groups. Every group has to be involved and that includes labor. We play a necessary role. We play a vital role. We play an important role.

If all parties recognize and respect each other's responsibilities, then we can all be winners in this age of high technology. The attitudes of all of us must change drastically or the era of the chip may hasten the demise of our industry's stature in the increasingly competitive world market.

* * *

A Company Experience — The Hammond Mill

Brian MacLeod
Manager, Personnel Administration
British Columbia Forest Products Limited, Vancouver, B.C.

I am going to underline some brief historical background about B.C. Forest Products Limited, Hammond Division, the challenges we faced during the construction and start-up phases, and how we met those challenges.

First of all, I'll give an outline of the events which happened after a decision was made for a new $35 million cedar sawmill. Secondly, I'll explain the challenges we were faced with building a new mill at the same time as running the old mill, then training the existing work-force and transferring them to operate the new mill all on the same site at the same time. Then I will look at the problems we faced throughout the various stages and relate them to training. Finally, I'll examine what things we would have done differently were we to do it over again.

Background and Events Surrounding the New Sawmill Decision

If you can visualize for a moment, I'll try and paint a picture of what the Hammond mill site looked like and you'll be able to reflect on that picture as we go through this process. First of all, on the mill site was an old sawmill which commenced production in 1914. To one side of the mill were two very modern planer mills; on the other side was a shingle mill built in the early 1900's.

The decision was made to shut down the shingle mill as it was no longer a viable operation. On the heels of that event, a decision was made to close the old cedar mill and build a new one on the same site. What did that really mean? We had to shut down the old shingle mill; move those shingle mill employees over into the old sawmill; start building a new sawmill adjacent to the old facility; and prepare the employees from the old shingle mill and sawmill to be capable of operating an ultra modern sawmill.

Our biggest challenge, as we saw it, was to overcome the fear our 'old timers' had of a computerized mill. It was presenting a security threat in the mind of a large number of our employees who had been with us anywhere from 20 to 40 years, not only because of reduced numbers required to operate the new mill, but it was going to change their work-life dramatically. Here we had this group of employees wondering how in the world they were going to adapt to all these new methods and concepts. They're thinking, "I'm really too old for this change at this late stage in my life". Quite a number of our old timers were content to continue working in the old mills where they had started their work-lives some years ago. They wished at least that we could have kept the old mill running until such time as they retire, and then if we wanted to start up a new mill that would be fine with them.

However, that wasn't the case, so we had to face up to the challenges of trying to instill a sense of belonging in what was to be our new mill when it came time to put that unit into operation.

So what's was our timing to be? We were in early 1980 and talking of a mill start up in some two and a half years. It sounded like lots of time to build a mill and encourage interest in a new operating facility and train our employees. As it turned out, we could have used more time. Here's why.

Construction of New Mill

Construction is underway now and we've all spent a number of months watching the contractors put the foundation of the mill in place. Now it's time to start thinking and doing something about the involvement of our employees in this new project so they will be committed to the forthcoming operation. In the early stages of discussion with the plant committee and

local union we find ourselves in the midst of an industry-wide strike by the IWA over contract negotiations. Then we find that we are having some difficulties between our trades people and the construction trades. That takes some ironing out with the construction local, plant committee and the tradesmen involved.

Then we face a raid by the Pulp and Paper Workers of Canada against the IWA at Hammond, and they make an unsuccessful but very disruptive attempt at taking over the IWA certification. If all this wasn't disruptive enough, in the midst of the raid our plant committee chairman and vice-chairman, who have been heavily involved throughout all of the discussion regarding the new mill, are both stripped of their office as a result of their involvement with the PPWC raid. So we find ourselves with a new executive to deal with and that doesn't make things any easier. It's almost like starting over. So much for a nostalgic view of some of the labor problems, but it's a clear indication of the kinds of things that a management group faces when they think they have a clear plan ahead to organize the development of staff and employees to operate a new facility.

It's easy to put a plan on paper, but when it comes down to actually implementing and carrying through with that plan, we all know what can happen. We're glad we started discussions early, but we could have used more time.

How Did We Introduce the Employee Involvement Process? What Was It?

We met with the plant committee and the union local and we told them how we wanted to place communication with employees on the highest level. Everyone agreed that it was going to be necessary to involve the employees as much as we possibly could and to communicate with those employees so that eventually there would be a sense of belonging in that new mill once it was time to start up.

We then held discussions with CEIC, or Canada Manpower as we called them, and put together a Manpower Consultative Services (MCS) agreement which provided an umbrella organization of management, union, employee and supervisor to jointly sit down, talk, and set some common goals and objectives in a methodical, practical approach to communications, ideas and training for the new mill. Throughout the process we retained the services of a consultant, Dag Furst, who acted as a catalyst and gave us inspiration to carry on with a very heavy program. Our steering committee chairman was Claire Alcott.

The involvement process wasn't a simple arrangement. It was an organized approach to communicating with employees regularly and it provided an avenue for employees to air their ideas and suggestions and have them heard by the project group that was building the mill. It was formally set up to respond to the employees. Since the structure of the program included supervision and employee representation, in addition to union and management, it really kept our finger on the pulse (Figure 1).

Our biggest downfall was creating a degree of involvement which led employees to think they would have more influence over the design and equipment selection, etc. than was originally anticipated. Otherwise the program was a success and paved the way for employee training and transition.

There were examples of success and failure in the minds of both employees and management throughout this process. There were situations where operators or tradesmen suggested change to the mill design or operation and their suggestions were implemented. There were also times when suggestions weren't implemented because of cost or philosophy and we live with some of those 'sore thumbs' today. There were other times when suggestions or ideas weren't implemented and after the mill was started up it was found that we wished we had implemented the suggestion as we ended up putting the idea into effect at additional costs.

This whole employee involvement process set the stage for generating interest and enthusiasm through construction and start-up.

TRAINING PROCESS (Figure 2)

Mill Tours

We began by conducting regular tours of the new mill and employees really started training from the first time they went on these tours. We had tours scheduled as construction permitted and changes became significant about every three months so that employees could see and hear an explanation of the new construction and the changes taking place as the new mill took shape. The tours were held following the end of day shift when the construction crews were out of the mill and the operators and supervisors could look around and become familiar with the new site eventually to be their new work place.

Crew Meetings and Area Groups

Another phase of training came about when we held crew meetings after shift to talk about progress. From these general sessions the groups were broken into area groups. Area groups were formed by employees with common job interests such as edger and gang operators; head rig operators; drop sorters and transfers; cut off and trim saws; conveyors and chipper/hogs.

These operating groups got together under their foreman/instructor. In addition, there were maintenance representatives in each group. We decided early in the construction phase that our foremen were going to be the instructors or trainers of the operators. These groups took field trips to other mills that had similar or the same equipment. In some cases they travelled as far as California. These field trips proved interesting and invaluable in the training process wherein operators and foreman alike had an opportunity to view a more modern facility, talk to the operators and foreman, and realize that this new age of computerization and highly automated equipment wasn't anything to be afraid of or feel insecure about. They could look forward to a modern plant with much better working conditions than what our people had been exposed to for years. It was all training and we had a long way to go.

The Weekly Newsletter

Due to the amount of activity that was taking place on the mill site on a day-to-day basis, we needed to establish some form of communication that would keep people up to date. It didn't seem to matter how hard we tried to ensure that we communicated with our employees on a regular basis, it seemed that things slipped by. So we set up to produce a weekly newsletter (Figure 3) that reported accident prevention statistics and matters of interest, the mill production, the maintenance items that were in process, and what was happening with the new mill construction and training process. Employees were very pleased with the newsletter. As a matter of fact, they were more positive about the newsletter than any other single thing we did.

Even though we were putting it out every week, we still failed to mention some things that needed to be communicated to employees and they didn't hesitate in reminding us of them. For those of you who have a weekly newsletter you'll know what I'mm talking about. The newsletter is still in place at Hammond and serves a very useful purpose, is well read and looked for on a weekly basis, as one might look for a newspaper in the evening.

Scale Model

A decision was made in the early stages of development to spend a substantial sum to purchase a scale model of the new mill. It wasn't difficult to justify the expenditure for this model because it would help with the final design and construction of the new mill, as well as serve as a valuable training tool. Since the model was built to scale, it graphically illustrated some design or drafting problems that would not have been detected until the actual piece of equipment or installation was in place. Design flaws would have been costly to remove and reconstruct, so we fortunately caught these things before they were installed.

As a training aid, it provided employees with a full-scale visual opportunity to see exactly what the new mill was going to look like once it was completed. It was one thing to tour the mill during the construction stages and wonder about the approximate location of an operator's booth or station, or try to visualize the lumber flow, etc.; it was yet another to be able to view the model and see the operating stations in relation to one another, converyors, bandsaws, headrigs, hulas, endtrims, walkways. You name it it was all in the model for employees to see. The basement of the mill, the operating floor and the sawfiling area on top all one in relation to another. It was a great training aid for both operating and maintenance employees throughout the construction and start-up phases.

Operator Training

Now we need to look at setting up some formal training for our trades people in particular, and eventually do some further training with our operators, keeping in mind that the operators are being trained as the mill is built, as pieces of equipment are installed, without any hands-on training at first, until their job stations were in place. There were a few exceptions. We constructed a mock training unit for the sawyers cab, with chair, console lay-out and, most importantly, the control lever. We changed from a right-handed rig to a left-handed operation.

Many hours were spent discussing, arguing, wondering about what operators and some supervisors thought may be insurmountable problems. They felt we were trying to cut these guys in half because, in their minds, there was no way they could change from a right to a left hand operator. Amazingly, the changeover went without a hitch. It was perceived as an almost impossible event when the decision to change was first communicated to the headrig operators. The hands-on training took place in the mock situation and when construction was completed the operators took over their job stations and actually put the mill into production.

We held meetings for the first month or so during mill start-up in the lunchroom before shift with the total crew to review the events and problems of the previous day. The crew was reminded that they were expected to start-up slowly and carefully and that we weren't expecting substantial production out of the mill. We wanted operators and maintenance employees to become familiar with their new working environment and we didn't want anyone getting hurt.

From the general meeting each day, the crew broke into their area groups to discuss specific problems before they went into the mill for the day of operation. For start-up training purposes, we ran a training shift for two weeks on day shift only. During this period both shifts worked together. Thereafter, we ran

alternating weeks with one shift operating the mill while one shift was off. It took anywhere from two days to eight to ten weeks for operators to become familiar with their equipment. The mill was up to operating capacity in 18 months.

Trades Training

How did we go about it? Aside from the upgrading that people had taken from time to time to improve their skills and help them maintain the equipment that we had in our antiquated mill, employees have been exposed to very little training over the years, except for possibly a smattering of electronics training. It's now time to take those same trades people, of which few had any advanced training although some had served apprenticeships recently or had come to us from a more modern facility and upgrade their skills to be able to maintain and trouble-shoot the highly automated equipment they were going to face in the new mill. We faced a real dilemma. We had the old mill to maintain, as it was operating on a normal daily basis, and yet we had a maintenance force that needed training to meet the challenges of the new mill. Therefore, all this training had to take place in a relatively short period of time, not too long before mill start-up, and with as little disruption as possible to the maintenance of the old mill.

At that point we decided to strike up a relationship with the British Columbia Institute of Technology (BCIT). We had discussions with representatives from the industry services department of BCIT and they organized a needs analysis program that would determine the general needs of the trades people to meet the requirements of this new equipment that we were going to be installing in the mill. BCIT representatives met with the suppliers of new equipment to determine what the maintenance requirements would be. They talked to other companies using such equipment. They also met with each of our trades people individually and in groups to determine the extent of training that we were going to have to provide.

In addition, BCIT provided us with maintenance and trouble-shooting manuals for each piece of major equipment. The final endeavor, undertaken as a pilot project by BCIT and jointly funded by CEIC, BCIT and ourselves, was to video-tape some of the training material that was used in the instruction of the maintenance employees before mill start-up, so that it could be used at a later date to train new maintenance employees or to retrain or familiarize the employees who had previously been exposed to the training. These video tapes would allow these people to refresh their memories with material about the equipment that they may not have had an opportunity to work on since they were originally trained.

As I mentioned, it was a pilot project but, unfortunately, not a success story. However, BCIT is doing everything they can to produce the tapes as planned and it is anticipated that they will be of a generic nature so they will be useful to other employers with similar equipment.

Trades employees were trained in classroom sessions by equipment suppliers and hydraulics and electronics expert instructors. They spent part of the day in the mill and part in the classroom. Specialized training was given to each trade with interface training provided for all trades. You'll see from Figure 4 the kind of training packages we and BCIT put together. The final training opportunity for tradesmen presented itself in the early stages of mill operation when we had some of our maintenance tradesmen assigned to the contractor's supervision for a period of about 10 weeks to work along with the contractors, tradesmen to finish some construction work. Others got intricately involved with supplier representatives in debugging and trouble-shooting the new systems.

During start-up, while some of our tradesmen were working with the mill construction crews, the balance of our trades people other than for shift coverage worked on the alternate shift to perform maintenance.

Supervisory Computer Training

We also wanted to teach our foremen to understand and be more comfortable with computers. Chuck Spong at BCIT, who used to work for Weldwood, conducted the sessions for us and did a fine job of indoctrination into the computer world. He set up computer stations in a classroom setting and taught the basics in a hands-on fashion of the hows and whys of computers. This helped build confidence in our supervisors, although I don't think we went far enough with this training.

The Council of Forest Industries (COFI) and our quality control supervisor conducted week-long product recovery courses for all employees that were going to be in operating jobs in the new mill. We know the course was effective because we even had increased recovery in the old mill the week following the first course. Follow-up sessions were held about nine months after the new mill was operating and recovery improved in the new mill dramatically. It was a very productive experience.

What Would We Have Done Differently So That Our Training Program Would Have Been More Effective?

When I was preparing for this session, I thought that if the fellow talking about this subject was a consultant, this was the point he would break everyone into sub-groups to list all the ideas you may have. Unfortunately, I have to do this myself.

What would we have done differently? That's a really difficult question to answer.

Its hard to be critical for when the mill started up we had a very short period to capacity production, hand-in-hand with an accident prevention program that was the best ever in the mill's history. We didn't incur any lost time injuries for four months during the transition period. Our crew turnover was lower than ever which was partly reflected by the economic times and partly due to the excitement of wanting to be party to starting up the new mill. Although we view the project as a success, there were shortcomings.

We created false expectations in the minds of employees regarding their involvement or input into the mill design. We tried not to, but we weren't totally successful. There are still employees who don't agree with some things we've done and remind us that had we done what they suggested, we wouldn't have a particular problem today. The reverse is, of course, true also.

As hard as we tried, there were times when we failed to communicate as well as we should have. That was probably the most difficult task of all.

As for trades training:

- We should have done more training to develop a better understanding of computer controlled equipment.
- Our original trades training concept was to have an on-site trainer through BCIT. He would have done a lot of the training and all of the coordination and follow-up necessary. This fellow would have lived in Maple Ridge and worked at the mill, which would have given him an on-site feel for the training necessary. Our overall program suffered when this concept was set aside because the individual chosen, due to personal commitments, was unable to follow through with his original plans.
- Producing video training tapes is a very costly endeavor if one tries to engage professionals in the process. This project was a pilot for BCIT and cost them a lot of money. However, the final product will be excellent when the tapes are completed.

There is no doubt that an endless amount of training can take place at any time for any project. We decided early in the time schedule to involve employees in the overall program for a multitude of reasons. We think it was successful and would wish everyone success with whatever approach they take.

* * *

Figure 1

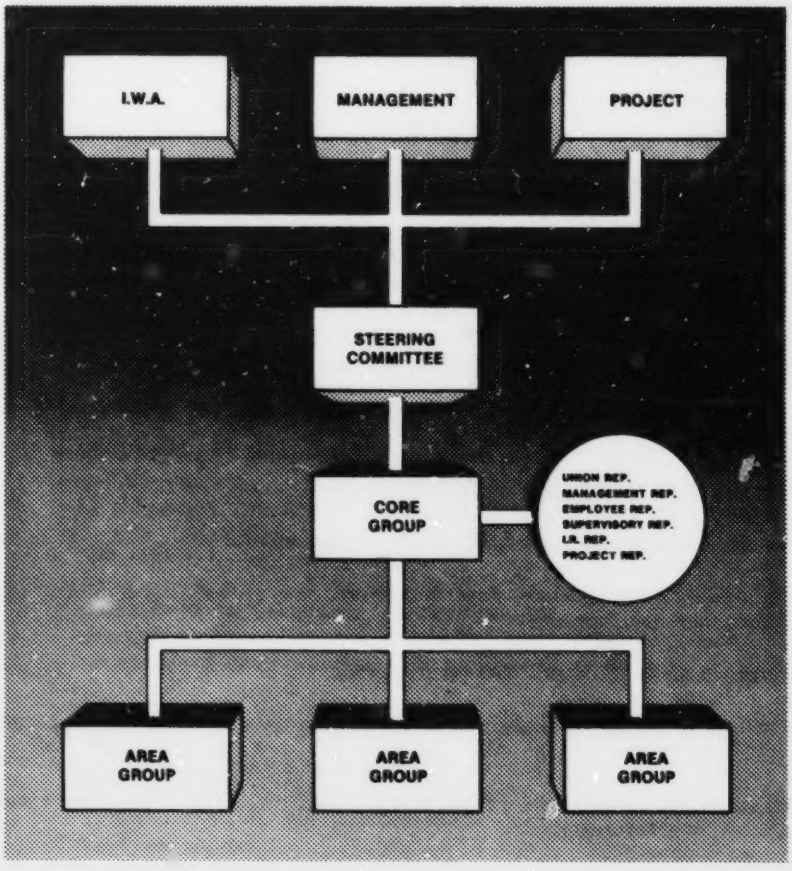

Figure 2

The Training Process

- Mill tours and field trips
- Core group meetings
- Crew meetings
- Area group meetings
- Weekly newsletter
- Use of model for operator training and trades training
- BCIT's involvement
- COFI's recovery course
- Training supervisors and supervisor's training crews
- Trades training

Figure 3

July 4, 1980

"Special Edition"

New mill project

The core committee, formed to co-ordinate crew involvement, met on June 27 and July 3 to formulate terms of reference for the core and ad hoc committees.

The committee decided to change the name of the "ad hoc" groups to "area" group to more properly reflect their function.

Area groups will have the following reponsibilities:

1) To communicate on a regular basis with crews in their in order to:

- *keep the crew informed of developments in their area and in other parts of the new mill.*
- *Solicit ideas and suggestions.*

2) To develop proposals for discussion with the core group.

3) Attend meetings with their group and the core group during regular working hours and during off hours.

Each area group will be composed of two crew representatives (preferably one from each shift), one supervisor and one project representative.

Area group members should have a good knowledge of the mill and should be good communicators.

Straight-time wages will be paid for all hours spent on area group business.

Anyone interested in serving on an area group should contact a core group member (see "update" July 2/80) by July 7.

Area groups are:

Safety & Environment
Manpower Training &/or Technological Change
Maintenance
Head Rigs

Figure 4

Training Course Prior to Start-up

- Process control for supervisors - introduction to computers
- Mini problem solving courses for supervisors
- Quality and size control - product recovery (COFI)
- Steamfitters hydraulics training
- Instructional techniques for foremen/trainers
  - operator trainers so foremen would have a consistent approach
  - maintenance trainers to train their groups and crews.
- Basic electronics courses 1 and 2 - Electricians
- Specific electronics course - electricians
  - D.C. drives
  - Dynamic controls - network controls
  - Maxi mill controls
  - J. bar sorter and log bucking controls
  - Programmable controls
  - Bearings & lubrication
  - Hydraulics interfacing
- Millwright courses
  - Kockums band saws
  - Sherman edgers
  - Newnes sorter
  - Hydraulics interfacing
  - Bearings & lubrication
- Sawfiling courses
  - band saws, edgers, carbide instruction, etc.
- New mill cutting philosophy - all employees

University of Victoria Engineering Co-op Program

Lawrence Pitt
Engineering Co-op Co-ordinator, Faculty of Engineering
University of Victoria, Victoria, B.C.

Getting out into the real world is what co-op education is all about. Unlike a typical university education where a student studies academic subjects during the school year and sometimes dabbles in the workplace during the summer, co-op integrates academic studies with relevant work experience starting from the first year of studies.

The co-op student has vital work experience prior to graduation, unlike the typical university graduate who is usually only beginning to venture into the work place after graduation. The combination of work experience and academic studies achieved by co-op education produces a highly motivated, well rounded, capable graduate who is much in demand.

A new faculty of engineering was established at the University of Victoria in February, 1982. Some call it a high-tech faculty but we refer to it as a modern faculty. The steam engine was high-tech in its day; today it is the computer and the fuel is information. Accordingly, our engineering program is specialized, offering degrees in electrical and computer engineering. These are fields which have increasing demand for well-trained graduates.

Engineering students at the University of Victoria will progress through a program that has three major components:

1. **Technical Subject Areas**
   - Engineering fundamentals
   - Microelectronics
   - Very large scale integrated circuit design
   - Telecommunications
   - Digital signal processing
   - Computer engineering
   - Software engineering
   - Computer-aided design and manufacture, CAD/CAM
   - Control systems and robotics
2. **Complementary Studies**
   - English composition
   - Technical writing
   - Law
   - Economics
   - Social aspects and impact of technology
3. **Co-operative Education**
   - Interfacing with the real world
   - Work experience

How Does the Co-op Process Work?

Student selection: Co-op students must be above average academically to gain access and to remain in the program.

Work terms: The academic program is arranged so that the students may participate in six four-month term periods during the course of the program, thus they may have up to two years equivalent experience. Work terms begin in January, May and September.

The availability of co-op students throughout the year permits employers to rotate various students to fill a year-round position, or to opt in or out of participation in the co-op program depending on workload, funding or other factors.

Job descriptions: Approximately four months before the start of a work term employers are asked to provide job descriptions for the positions they have to offer outlining duties and responsibilities, education and experience required, salary range, and location. The job descriptions are then posted in the faculty for the co-op students to consider.

Student placement: Students select the jobs that they feel best suited for, and their resumes are forwarded to the employers, who then choose the applicants they wish to interview. On completion of the interviews, which are normally held on campus about two months before the work term begins, employers rank the students they would be prepared to accept, and students also submit their order of preference for positions. The co-op coordinator then negotiates the best possible matching of jobs with students, attempting to satisfy the requirement of both groups.

Salaries: Salaries paid to co-op students are determined by the employer within their organization's wage structure. As students progress through their programs and assume more responsibility on work assignments, it is expected that their salaries will increase as merited. Information on average salary ranges is available upon request.

How Do Employers Benefit?

By employing co-op students to do certain low-level duties, permanent staff can be freed to perform more demanding tasks.

Co-op students can attempt your short-term or exploratory projects when skilled manpower is not easily available. Also, you as a manager have a cost effective means of evaluating the potential and performance of prospective permanent staff without making a long-term commitment.

Perhaps one of the most important benefits to employers is interaction with the University. Opportunities for exchange of ideas and new developments will most certainly occur. This is a two-way street, though, since the University also benefits from the interaction with industry. New developments in industry, requiring further investigation on tough technical problems in need of solutions, can stimulate relevant research at the University.

Through the engineering co-op, you, as an employer and member of the community, will be able to influence and improve the academic program by being a tough and demanding critic. Your feedback will help maintain the quality and relevance of our academic program.

You in the forest industry have implemented technological change and are gearing up for more. We at the University of Victoria are gearing up for technological change too. We wish to produce engineering graduates who are both effective because they are innovative and adaptable to a changing technological world.

My purpose is to ask you to consider how you can make effective use of the engineering co-op and thereby gain access to these bright, highly motivated student employees.

* * *

Year	Fall September-December	Spring January-April	Summer May-August
1	CAMPUS	CAMPUS	WORK TERM
2	CAMPUS	WORK TERM	CAMPUS
3	WORK TERM	CAMPUS	WORK TERM
4	CAMPUS	WORK TERM	CAMPUS
5	WORK TERM	CAMPUS	

Figure 1

The Industrial Regional Development Program

Robin Dodson
Regional Executive Director
Department of Regional Industrial Expansion, Vancouver, B.C.

The Department that I represent is not well known because it is brand new. The Department of Regional Industrial Expansion, or the acronym that we use, "DRIE" is the product of an integration of two major departments of the federal government that previously were both involved in domestic industrial development. Government reorganizations are not the sort of thing that inspiring talks are based upon, so I won't go into any great detail simply to underline that those of you who had some familiarity and knowledge of DREE (the Department of Regional Economic Expansion) or IT & C (Industry, Trade and Commerce) will be glad to know that those two departments live on in terms of their mandate and some of their activities in this new department called 'DRIE'.

The government decision that led to the amalgamation of DREE and IT & C in early 1982 made a number of basic changes in the structure of the federal government vis a vis the federal role in economic development in the country. Amongst the more important changes that were made at that time was the transfer of all export trade development responsibilities, which previously had been a responsibility of Industry, Trade and Commerce, to the Department of External Affairs. The Trade Commissioner Service that some of you will be familiar with is now a component of External Affairs rather than Industry, Trade and Commerce. The integration of the two domestic departments was basically an attempt to integrate the twin government priorities that have been held for many years in this country of a dedication to improving the competitiveness and the excellence of Canadian industry across the country on the one hand, and on the other hand, a commitment to providing economic development opportunities to all regions of the country.

The new department basically has a very general mandate to increase business and commercial activity everywhere in the country. The department is the advisor to the federal government on matters of industrial policy and industrial development throughout Canada. In this role, the department essentially attempts to influence those horizontal policies of the government in the areas of tax, monetary and fiscal policy and trade policy to improve the climate for industrial development.

In doing this, the department works directly with both industry and labor in a consultative framework. I think the best example of this, particularly in the last year, has been the establishment of several ministerial task forces, reporting to the Honorable Ed Lumley who is our Minister, and a number of vital sectoral components of the Canadian economy. Examples would be aerospace, auto parts, the petrochemical industry and, of course the one which you are most familiar with, the forest products industry. Indeed, The Forest Industries Advisory Committee, which continues to be co-chaired by Ian Barclay and Jim Buchanan, made a preliminary report to the government late last year in the form of the "Green Book", as I think it is commonly known throughout the industry, with a number of recommendations for improvement in the government environment and government policy as it affects the health and development of the forest products industry. You may not be aware that the government has in fact published a preliminary response to tnose recommendations which is now available.

In addition to the role that our department plays vis-a-vis the other departments of the federal government in attempting to influence their policy, we also represents part of the government's commitment to ensuring that all regions of Canada

have an opportunity to develop to the maximum the opportunities that are available in each region of the country. This is reflected in two ways: first of all in the program structure of the department and secondly in the organizational structure of the department, which is a much more decentralized organizational structure than was previously the case, particularly with IT & C. In short, all of the services, programs and information packages that are available from DRIE are available in British Columbia at our offices in Vancouver, Prince George and Victoria.

Finally, the department is the principal government instrument of direct financial assistance to the manufacturing, processing and tourism industries across the country. And the centerpiece of our set of program instruments that provide direct financial assistance is the Industrial Regional Development Program. IRDP, as it is commonly referred to, was developed at the same time as the departments were integrated for a number of reasons. First of all, to simplify what had become a very confusing array of 'alphabet soup' programs with a variety of names that even those of us within government occassionally had some difficulty in keeping up to date with. So a number of these programs that were previously offered by IT & C and DREE have been amalgamated into this new program structure.

The delivery of the program is again simplified by virtue of the fact that it is available from all of the offices of the department everywhere in Canada. The decision-making process that has been set up inside the department is such that the vast majority of projects and applications can be dealt with at the regional level without the necessity of projects having to go to Ottawa for final approval. So in theory it should be more accessible and it should be faster. I am sure you would commend those objectives.

The program is also designed to be sensitive to regional needs and in particular to be sensitive to the regional disparities that continue to exist in this country and which clearly have not been helped by the recession of the last three years.

And finally, the program is designed to cover all stages of the project and product development cycle to provide targeted levels of financial assistance from the earliest stages of the project, when it is in the pre-feasibility stage, to the very late stages of projects, where products have matured and are in fact undergoing significant adjustment pressures because of increased competitive forces.

(The following outline is based on an audiovisual presentation which formed part of Mr. Dodson's address.)

Improving the competitive position of products aimed at world markets is the reality facing Canadian business in the years ahead. With economic conditions improving, better business and government teamwork could strike the balance necessary for Canadian business to remain a competitive force in the marketplace. To help Canada compete, a government program has to be responsive to the needs of the business community and sensitive to regional and local business and economic conditions.

Doing business with business in the face of this competition is the goal of the IRDP, the Industrial and Regional Development Program. IRDP is a new approach intended to be more flexible, more regionally and locally sensitive and to take into consideration the realities of the marketplace, domestically and internationally. IRDP is a wide-ranging program aimed at promoting development in all parts of Canada, thereby providing assistance where and when it is needed. It is a national program available for all Canadians.

Several assistance programs have been incorporated into the new IRDP core program, reducing the number and increasing the efficiency of delivery. This simplification of government assistance programs should help produce more effective, competitive operations for Canadian business people. For the first time direct federal assistance is available throughout all of Canada. It is a fact that not all areas of Canada enjoy the same economic prosperity. This program, although a national program, has been designed to provide help where it is needed most. Targeting support is achieved through the use of a development index based upon facts from Statistics Canada using 260 of Canada's census districts.

The development index is reviewed annually. It takes three main factors into consideraton. These are: the level of unemployment, the level of income per person and the fiscal capacity of the province. These three statistically-based criteria form the basis for the targeting of assistance. The greater the need, the greater the share and incentive for investment. There are differing tiers of assistance: Tier One represents the basic national level of support; Tiers Two, Three and Four provide progressively higher levels of assistance. The program also provides special assistance for short-term economic downturns in Tier One regions.

To qualify for assistance, projects must be commercially viable, must be seen to be of significant national and regional economic benefit, and must be projects that would not proceed without IRDP aid. Most individuals, corporations, partnerships, co-operatives and non-profit organizations are eligible for consideration. Manufacturers, processes and certain tourism facilities are eligible. IRDP funds are available in the form of grants, direct contributions,

repayable contributions, participation loans, and loan guarantees.

IRDP gives you help where you need it, when you need it. Whether you are just starting out or expanding an established industry, IRDP could make a difference. It covers most phases of the business cycle, the industrial development, innovation, establishing new facilities, modernization and expansion, marketing and restructuring. Stimulus for industrial development includes assistance to economic, business or technological institutes and to non-profit centres or institutions. Assistance for innovation provides help for developing technological capabilities, for developing new products, for finding new and more competitive processes and for feasibility studies. IRDP establishment assistance can help build new plants and purchase up-to-date equipment. New technology can be applied to a spectrum of existing processes and products to make them more competitive assisted by IRDP modernization and expansion incentives. Marketing assistance is available for consultant studies and for projects such as market research assessments of events and attractions to help promote Canadian products. With an objective for improved competitiveness, restructuring is sometimes the only viable alternative.

Canada must compete. We must be among the most technologically advanced, the most highly productive, the most innovative and efficient to win the race for domestic and world trade. The Industrial and Regional Development Program is a step in that direction.

(That concludes the text of the audiovisual presentation.)

The program that has just been described by the audiovisual is described in greater detail in an available brochure, so I won't repeat the information that is contained in that. I would simply like to say that obviously this is a very powerful and flexible program and, therefore, in spite of the one hundred billion dollar total expenditure estimate of the federal government for this coming year, there is not an unlimited amount of money available to be expended under the program. As a result, we are attempting to select and identify on a regional basis those priorities which seem to fit the particular industrial circumstances of those regions.

In British Columbia, we have basically chosen two priorities as a result of consultation, as a result of analyzing the situation that currently exists in the B.C. economy. The first priority is the modernization and productivity improvement of the traditional resource-based industries in the province, recognizing that in many circumstances this will result in either a maintenance, at best a maintenance and occassionally a reduction, in the employment levels that are experienced in those industries.

The second priority that we have chosen for use of this program in B.C. is the diversification of the existing industries in the province. Diversification in three areas: new products from existing industries; new markets for existing products; and in those areas where a long-term competitive advantage can be demonstrated, the initiation of entirely new industries in the Province. I should mention that in B.C., vis-a-vis the development index that was mentioned in the audiovisual, we have Tier One, Tier Two and special Tier Ones in B.C. Again, these will be identified by the regional district which has the same boundaries as the census division in the province. I have to make one footnote with regard to the forest industry and the application of the IRDP program. The Forest Industries Advisory report which I referred to earlier recommended among other things that the government should think very carefully about providing direct financial incentives in the pulp and paper industry and, in particular, for the creation of new capacity. And recommended in addition is that the government think carefully about offering financial incentives in all aspects of the forest industry for modernization and productivity improvement on the basis that such financial incentives tended at times to distort the marketplace and the normal market pressures.

In the response to the Forest Industries Advisory Committee's recommendations, the government has indicated that we are looking very carefully at all aspects of the forest industry in the country with a view to determining whether or not they should be eligible for the financial assistance that has been described and that is available from this program. The focus of this attention and this review is on new capacity, and I think again it would be no news to any of you to know that that is a particularly critical problem in the pulp and paper industry. For this reason any project applications that we have from the forest products sector that involve the development of new capacity are essentially on hold until that review has been completed and until the Minister and the government have made a decision on the recommendations on the Advisory Committee.

In the meantime, however, there are a number of elements that are being implemented without hold-up pending receipt of that analysis. These are the elements of the program that were mentioned in the audiovisual, including the innovation component of the program, aimed at assisting the design and development of new production equipment and the design of new production processes. Financial assistance for the adaptation of microelectronics to existing production systems is also an element that we are proceeding with the implementation of. And

finally, the acquisition of new equipment with the sole purpose of modernizing existing productive capacity are projects that we are able to deal with and able to proceed with at the present time.

Finally, I would have to say that, relative to the theme of this seminar, the federal government and our department sees the modernization of the sawmilling component of the coastal industry as a vital factor in the health of the British Columbia economy in the years ahead. The role that the government would like to play and the role that our department would like to play is really threefold. First of all, through the support of seminars such as this, to assist in the process of providing information, of sharing experience and generating ideas in the minds of the operators in the industry which you represent. Secondly, through continued consultations with both industry and labor, to improve the climate overall that so vitally affects the performance of this industry across Canada. And finally, through the selected use of program assistance such as that available under IRDP, to facilitate the modernization process where a need can be demonstrated.

* * *

Profit Opportunities Through High Technology

Jim Swanson
Manager, Lumber Manufacturing Technology,
Forintek Canada Corp., Vancouver, B.C.

I would like to review some of the experiences we have had at Forintek, based on our files and studies, that will indicate existing profit opportunities in sawmilling operations. The worldwide focus today is on improving productivity and recovery in sawmilling operations.

Forintek has been involved in these activities for a number of years through a project known as the Sawmill Improvement Program. It began in the Eastern laboratory when Forintek was part of the Canadian Forest Service, Eastern Forest Products Laboratory. With the formation of Forintek, these activities have expanded rapidly. In the past four years, we have had the opportunity to study in excess of 70 individual sawmill log breakdown systems in over 50 different sawmills. As a result of these studies, we have gathered a large amount of information and data. We generally find several areas in the manufacturing process that lend themselves readily to improvement. We have made the objective of the program to identify these areas in existing operations and estimate their potential economic impact.

There are at least six areas that can nearly always yield substantial benefits (Figure 1). These include the following: improving the log quality entering the mill, paying careful attention to the log allocation within the mills, optimizing log breakdown procedures, minimizing lumber sizes, improving productivity itself and establishing efficient drying practices.

All of these can have a substantial impact on the overall profitability of any sawmilling operation. For a few minutes, I would like to discuss examples we have generated with actual mill data. I'll start with improving log quality entering the mill.

In the area of log quality entering the mill, there are five or six areas that we are particularly concerned with. The log quality entering the mill is extremely important for several reasons, one of the primary ones is that mistakes, particularly in log bucking, cannot be corrected anywhere else in the manufacturing process.

Normally, we are concerned with sweep, crook, log length, over length and debarking, to name a few (Figure 2). There have been extensive studies, and much information published on the effects of sweep and crook. I don't plan to cover these areas extensively. The other three points including log length, over length and debarking, are areas that should not be overlooked because there is often room for substantial improvements in economic benefits in these particular areas. Let me explain what I mean by log lengths.

Generally speaking, we like to produce log segments that will produce lumber in the sizes we are going market. In other words, we want to produce a correct nominal log length and give it a minimum trim allowance only. We collected data in a number of sawmills. Here are examples of some things we often see. This mill was marketing even length lumber in eight, 10, 12, 14 and 16 foot lengths which is fairly common. Generally, we market in two foot increments. The Number One log was 12 foot 9-1/2 inch actual log length. This log should have been trimmed to 12 foot 5 inches. It actually had a four and a half inch overtrim. Another log in the same batch was measured at 11 feet 10 inches. This situation is extremely detrimental because to get back to the next nearest lumber size, almost 17 inches of trim has to be removed. This represents a substantial loss in fibre. In a 16 foot log, that represents a 12-1/2 per cent loss of lumber. Although it is an extreme example, it is not uncommon.

In another sawmill producing even lengths, we found the average trim was running 6.9 inches in excess allowing for even and odd lengths. The particular mill, however, was only marketing lumber in the even lengths, so the actual overtrim was 8.6

inches. If we assume a five inch trim would be sufficient for this entire group of logs, the overtrim would average 3.6 inches.

If this could have been recovered as lumber, what would the benefit be? (See Figure 3.) We found that assuming most of the overtrim could be turned into lumber by careful bucking, we could increase our lumber recovery from 6.4 to about 6.51, for a lumber recovery improvement of 1.7 per cent. Now, 1.7 per cent is not a great deal, but what would it mean to a lumber operation producing 100 million board feet of lumber per year? It would add an additional 1.7 million board feet of lumber to that operation. We have calculated the potential benefit by assuming a selling price of $200 a thousand and subtracting a drying allowance of $12 per thousand and a planing and dressing allowance of $26 to come up with an additional lumber value of $275,400 (Figure 4). We would lose chip revenue, so we adjusted for lost chip revenue and still show a benefit amounting to almost $210,000 from a 3.6 average overtrim.

I will now discuss the area of debarking. Substantial savings can be made in debarking. We have a tendency to use too much pressure or too little pressure in debarking and as a result we end up with chips in our bark or bark in our woodchips. Bark in the woodchips is bad. These errors result in lost premiums from the woodchip buyers, or lost lumber recovery.

We used the Best Opening Face Program to simulate the effects of using excess pressure in the debarker and removing, inadvertently, a tenth of an inch from the log (Figure 5). A tenth of an inch all the way around would result in two tenths of an inch reduction in diameter. This calculation is based on a 6.4 inch diameter log, 12 feet long. We assumed it to have two inches of taper, and used the split taper and log cant portions of the Best Opening Face Program. You can see that normally this log would be expected to yield 27 board feet of lumber. If we removed one tenth of an inch of fibre because of debarking errors, this would be reduced to 24 board feet of lumber resulting in a reduction of lumber recovery factor from 7.22 to 6.42, or 11.1 per cent. What could this mean to a lumber operation producing 100 million board feet of lumber? (See Figure 6.) If we assume that instead of 11 per cent we only get two per cent, and ignore any revenue out of chips, we would add an additional two million board feet of lumber per year. Adjusting the value for drying and planing, we come out with a net benefit of $324,000 from a 1/10 inch loss of the outer shell of that tree.

Now let's discuss log allocations. Generally we are talking about yield and recovery as a function of production lines, and/or productivity as a function of production lines, and also profitability by diameters. The first two areas generally refer to running two production lines simultaneously. We studied a two production line mill. The small log line was designed to handle logs under seven inches, and the large line logs over seven inches. We found 10 per cent of the large logs were actually less than seven inches, so they were below the minimum, and 20 per cent of the small logs exceeded the seven inch diameter maximum. We analyzed that data for optimum allocation. The results are shown in Figure 7. We see that had the logs been processed on the proper line through optimum log allocation, we could have increased our lumber recovery from 5.77 to 6.01. This represents an overall improvement of four per cent in lumber recovery. What would this mean to a sawmill producing 100 million board feet. The four per cent increase would add an additional four million board feet annually to this sawmill (Figure 8). This additional lumber would have a value, adjusted for planing and drying, of $648,000. However, we would lose chip revenue. When adjusted for the loss in chip revenue, we obtained a potential net benefit to this operation of $492,000 based on proper log allocation.

The third area involves optimization of log breakdown and log breakdown systems. We all know the cost of delivering wood into the sawmill is rising rapidly so there is a strong emphasis and need to improve lumber recovery. We must remember a couple of points regarding applications of new technology. The log breakdown process itself is one of many processes in the mill. The overall recovery is only going to be as good as those processes that both precede and follow the log breakdown system itself. We can have the best computer controlled breakdown system, but if we are doing a lousy job either before or after, we are not going to get the full benefits.

There are some substantial things one can say for computerized log breakdown. Firstly, computerized log breakdown minimizes operator errors. Secondly, it allows you to target breakdown patterns for marketing purposes, either to maximize value or to produce products that are more marketable. This can have significant impact in terms of marketing. Computerized optimizing systems are dependent on two things: efficiency of the scanning system and efficiency of the diameter sort to sawing diagrams at the headrigs. The 11 per cent difference in recovery that we considered at the debarking station due to taking away a little excess fibre around the log can also occur at the headrig if your scanning is not accurate.

Now let's look at minimizing lumber size. There are three things that we generally have to do to maintain minimum lumber sizes. Firstly, we have to establish a minimum lumber size for our particular sawmill. Secondly, we have to track it on an ongoing and careful basis and stick to it to reap the benefits. What

are the components of a lumber target size? They include the final dry, dressed lumber marketing size, the green dressed marketing size, a planing allowance if we are planing, a shrinkage allowance if we are drying, and a sawing variation. Any lumber or wood in excess of these can be considered oversizing and unnecessary. We generally lose the excess in the form of lower value planer shavings. We would like to recover it as higher value chips and lumber. The following is an example of reducing a target size by 1/16th of an inch. The simulation indicated that the top two by four was increased from 12 to 14 feet by reducing the target size a sixteenth of an inch. This translates into a lumber recovery of about 2.6 per cent. Many mills today are again actively interested in lumber size control programs. We are finding that yield improvements from two to four per cent are commonly achievable and feasible. How much of this can be recovered is up to the mill, but generally it can be achieved at a minimal cost. What would this mean to a lumber operation producing 100 million board feet of lumber? (See Figure 9.) If we ignore the value of additional chips, focus on increased production and assume a two per cent increase in lumber recovery factor, the additional volume would amount to two million board feet annually, and would have a net value of $324,000.

Next I would like to discuss productivity itself. Productivity is extremely important and is significantly impacted by two items: downtime and delayed time. Downtime is the period when the machine is down due to electrical and mechanical problems. I like to focus on delay time. Delay time is that time when the machine is actually available for processing, but because of problems in mill flow, it is not processing material. Delay time is harder to detect and often frustrating to the operators. Because delays are usually of short duration, they are easy to overlook. We have measured delays in sawmills that range from less than one per cent to over 17 per cent. These delays are caused by such things as lack of material, logs being jammed up at the unscrambler, log handling problems, or surges, downstream delays or chipper jam-ups.

What do these delays in productivity cost? (See Figure 10.) We made the assumption that one could achieve a five per cent reduction in delay time. Since this five per cent reduction is associated with time that can be totally productive, it will result in an increase of five per cent in productivity. There are two ways to economically analyze the benefits of this. One is to look at the cost savings from a more efficient operation as presented next. Assuming fixed and variable costs of seven million dollars a year, we have recalculated the operating costs for this mill after reducing delay time by five per cent. This saved the operation 25 shifts annually. When pro-rated back to a year, we calculated $14,000 in variable costs per shift. Higher efficiency saves the variable costs, and this case would amount to about $350,000 per year. One would like to use the saved time for production, provided logs are available (Figure 11). This would increase production five per cent or by five million board feet, with additional revenue of about $1,125,000. Subtracting the cost of logs, processing, drying, and planing, which amounts to $640,000, we still realize a net benefit of almost $500,000 per year from a five per cent reduction in delay time.

Next, I would like to address lumber drying which can have significant impact on profitability. Generally, we dry to meet the 19 per cent moisture content standards. A general rule of thumb derived by several large companies states that a one per cent reduction in the moisture content, below the fiber saturation range, results in a one per cent loss in lumber value. This is generally the result of increased degrade. We can also derive benefits out of raising the average moisture content from reductions in heat and other kiln costs.

In the following we have analyzed the cost of drying from an average moisture content of 15 per cent down to 12 per cent, a three degree drop in moisture content (Figure 12). The three degree drop corresponds to three per cent decrease in lumber value, and since we are considering a 100 million board feet per year operation at a $200 per thousand price, this is equivalent to a $6 per thousand loss due to degrade. The costs of drying and heating amount to 35 cents per thousand board feet. Additional costs amount to 15 cents, for a total overdrying cost of $6.50 per thousand. This represents an annual cost in excess of $650,000 due to overdrying by three per cent. Shipping dryer lumber results in freight savings of about $1.10 per thousand. These have to be subtracted from the cost. The net cost of overdrying is still in the neighbourhood of $540,000. These potential benefits are the driving force for the development of new kiln control systems.

In conclusion then, the combined areas that I have discussed in relation to a 100 million board foot per year operation suggest substantial savings can be made (Figure 13). In this case, if we simultaneously achieved them all it would amount to 2.2 million dollars annually.

I would like to leave you with one final thought. Expenditures or costs incurred as a result of improving yields or increasing productivity, can generally be readily paid back.

* * *

Figure 1

Manufacturing processes that often can be readily improved

- Improve Log Quality Entering Mill
- Improve Log Allocation
- Optimize Log Breakdown
- Minimize Lumber Size
- Improve Productivity
- Reduce Drying Degrade 1

Figure 2

Factors to consider in determining log quality entering mill

- Sweep
- Crook
- Log Length
- Overlength
- Debarking 1

Figure 3

Recovery improvements from reducing overtrimming by 3.6 inches

	Log Volume (cf)	Lumber Tally (bf)	Lumber Recovery Factor	LRF Improvement (%)
Study Logs With Overlength	2847.2	18,222	6.40	
Study Logs Without Overlength	2798.8	18,222	6.51	1.7

Figure 4

Economic benefit from reducing overtrimming by 3.6 inches

Annual Production	100 MMbf
LRF Increase	1.7%
Additional Lumber Volume	1,700 Mbf
Additional Lumber Value	$275,400
Reduced Chip Value	$ 66,300
1,700 x 78 x 24	
2400 x $50/BDU 1	
Net Benefit	$209,100

Figure 5

Analysis showing potential recovery loss in debarking

Log Diameter (in.)	BOF* Yield (bf)	LRF	Difference (%)
6.4	27	7.22	
6.2	24	6.42	11.1

- 6.4 inch log
- 12 ft. long
- 2 in. taper
- split taper log and cant sawing

*based on a target size of 1.875 in. 1

Figure 6

Economic impact of removing 1 inch of wood during debarking

Annual Production	100 MMbf
LRF Increase	2%
Additional Lumber Volume	2,000 Mbf
Additional Lumber Value 2,000 (200 - [12 26])	$324,000
Reduced Chip Value	—
Net Benefit	$324,000

Figure 7

Potential lumber recovery improvement from correct log allocation

		Small Log Line LRF	Large Log Line LRF	Mill LRF	Improvement (%)
Study Log Allocation	5.51	5.98	5.77		
Optimum Log Allocation	5.64	6.31	6.01		4

Figure 8

Economic impact of proper log allocation

Annual Production	100 MMbf
LRF Increase	4%
Additional Lumber Volume	4.0 MMbf
Additional Lumber Value 4,000 (200 - [12 26])	$648,000
Reduced Chip Value $\frac{4,000 \times 78 \times 24}{2400}$ x $50/BDU	$156,000
Net Benefit	$492,000

Figure 9

Economic impact of reducing target size by 1/16 inches

Annual Production	100 MMbf
LRF Increase	2%
Additional Lumber Volume	2 MMbf
Additional Lumber Value 2,000 (200 - [12 26])	$324,000
Net Benefit	$324,000

Figure 10

Economic impact of 5 per cent productivity improvement from reduced costs

Annual Production	100 MMbf
Operation Cost (sawmill fixed & variable, excl. logs)	$7 MM
Operating Cost/Mbf	$70 Mbf
Delays	5% or 25 shifts
Normal Shift Production	200 Mbf/shift
Variable Cost/Shift	$14,000/shift
Variable Cost Savings (25 shifts x $14,000)	$350,000
Net Benefit	$350,000

Figure 11

Economic impact of 5 per cent productivity improvement including added production potential.

Annual Production	100 MMbf
Delays	5%
Additional Lumber Volume	5 MMbf
Additional Revenues	
- Lumber $200/Mbf	$1,000,000
- Chips $50/BDU	125,000
	$1,125,000
Minus Added Processing Costs for Logs, Drying and Planning (5 MMbf x $128/Mbf)	$640,000
Net Benefit	$485,000

Figure 12

Analysis of cost of overdrying from 15 percent to 12 percent moisture content

Annual Production	100 MMbf
Cost of Overdrying From 15% to 12% M.C	
- Degrade (1% Value Loss per 1% Decrease in M.C. (1% x $200/Mbf x 3% M.C.)	$6.00/Mbf
- Heat - add 104,000 BTU/Mbf (104,000 BTU x $3.33/MMBTU)	$0.35/Mbf
- Other Costs	$0.15/Mbf
Unit Cost of Overdrying	$6.50/Mbf
Annual Cost of Overdrying	$650,000
Freight Savings Due to Shipping Weight Reduction ($1.10/Mbf x 100 MMbf) Shipping Rate $4.45/cwt	$110,000
Net Cost of Overdrying	$540,000
or	
Potential Net Benefit	$540,000

Figure 13

Summary of potential economic benefits from six areas for a mill producing 100 MMbf annually

Elimination of Overlength	$209,100
Improved Debarking	$324,000
Improved Allocation	$492,000
Minimum Lumber Size	$324,000
Reduced Delays	$350,000
Eliminate Overdrying	$540,000
Total Net Benefits	$2,239,100

Planning the High-Tech Mill

Cliff Bowering
Plant Manager
Fraser Mills, Crown Forest Industries Limited, Vancouver, B.C.

I would like to outline a case history of the last project that we have handled as a company in the lumber area the new Fraser Mills sawmill.

Fraser Mills is on the Fraser River between the Port Mann and the Patullo bridges and has been a sawmill site for many years. The logs come to us by barge up the Fraser River and are dumped in the booming ground. The bundles are dewatered by means of a crane and the logs are moved by log loader to the dry land barker and cut-up plant. The logs go into the barker, which is a Nicholson 60 inch unit, and from there to the cut-off saw. The cut-off saw is a 108 inch unit. We have a maximum diameter into the mill of 60 inches.

A monitor gives the operator some instructions as to how he should buck that log based on scanner information and programming that has been put into the computer. The logs then travel through a second scanner to bins and the barking cut-up is separated from the sawmill. The logs are moved from the barker plant to the sawmill by a front-end loader. There is a capacity of about three shifts' storage in the yard which allows us to do some merchandising of the logs. We can also take out peelers for our veneer plant. The system also allows us to maintain the barker cut-up plant during the week, rather than having to wait until Saturday.

In the sawmill we have two headrigs, both eight foot double cut with chip slabbers, scanners and hydraulic carriages positioned by microcomputer. At the sawyer's work station the computer is on his left and the monitor tells him what is happening. We use programmable control and all the latest innovations in headrigs. They can both feed a central twin-band resaw. From the resaw the lumber can either be recirculated or sent to a pair of edgers. We have two five saw edgers and two 12-inch double arbor gangs. The edger and the gang are both handled by a single operator. The lumber then flows past a drop sort to the two trimmers. This is, by the way, a 26 foot mill.

After the trimmers, lumber passes through spray tunnels where an anti-stain chemical is applied. This is a green hemlock mill so we use the same anti-stain chemicals and wax pigment emulsions as other coastal operations.

From the spray tunnels, the lumber flows to the grading station and the sorter infeed. We have, again, two sorters and two grading stations. We have two 60-bin sorters, side by side, and they are patrolled by one person. From the sorters, lumber goes to the two stackers and then to the packaging station where the lumber is banded and stencilled as a finished product.

The Planning Stage

I would now like to discuss planning the high-tech mill which is really my topic today. There are a number of phases in any project. This is true of a large project, such as an entire mill, and it is also true of a small project, such as putting in an edger optimizer, a new trimmer or a new edger.

The Concept

There is the concept phase, the purchasing, the design, the construction itself, the training, the start-up and then the ongoing operation and maintenance. So you are never really finished with the project until you finally tear the mill down. And the important thing is to tie all of these various phases together.

When you start with the concept of the mill, you have to think in terms of all these other phases. You have to think in terms of how are we going to run this mill, how are we going to maintain it and how are we going to train our people. The other thing that I think is really important, especially in an old, established operation like Fraser Mills with people that have been there over 30 years, is to give those people a sense of ownership. You can't just take a mill and dump it on them and say, "Okay, here it is. I'll give you a tour of

it and then I want you to run it." because it just doesn't work. You have to give them involvement. And yet the involvement has to be tempered with the fact that you can't really design a mill with a huge committee. Somebody has to bear the ultimate responsibility. And somebody has to say, "Okay, I've heard all the input but this is the way it is going to be." So there has to be a balance between the two and that balance is not easy to achieve.

I think we have been pretty successful at Fraser Mills. A lot of it is due to the fact we are very fortunate at Fraser Mills in having some excellent people people who were right up to date on technology, even though we were working in a real old mill, an old 'steam driven' mill. I think, too, we were fortunate in that we had a pretty good understanding of our future log supply in that we were already running it in the old mill. We weren't talking about changing the log supply. So we had a good idea of that and in the concept phase it is very important to be able to describe the kind of logs that you are going to saw.

You also need to make some very basic decisions on what kind of products you are going to make. We spent many long hours talking and arguing about that. We finally ended up with a maximum size of four by 12 and a maximum length of 26 feet. For a coastal mill, those are pretty basic decisions that you have to make. We have had lots of people second guess us and we've maybe even had second thoughts ourselves, but basically we started with that and that's the way we ended up. The other thing we wanted to try and achieve was to have as much of the product on order, finished, out of the mill, as possible. We would like to achieve over 60 per cent. We are not achieving that right now largely because of the order file that we are forced to take. The other factor, of course, is that this particular mill was designed for the export market, and therefore metric sizes were a very big factor with setworks having to be programmable and infinitely variable.

In the concept phase of the project it is very important that you have a good knowledge of flow and equipment options. The only way to really get that is to see other mills, not just in your own area, but in the Pacific Northwest generally. Get out into the competitors' areas. I would say that although the logs in Scandinavia aren't anything like ours it is nonetheless important to take a trip over there because they do have a lot of really good ideas from which we can learn. Obviously discussion with suppliers is another valuable way of getting knowledge, as is attending this kind of seminar.

You must specify the process flow in detail preferably with in-house people. Once we laid the mill out on paper, we went through it carefully, step-by-step. Our sawmill superintendent, Wayne Beatty, and Bob Canfield, our electrical superintendent, spent countless hours defining what each push button was going to do. Only by getting down to that detail can you avoid a lot of the pitfalls that arrive during start-up.

The decision to go all-programmable logic control (PLC) was made fairly early. I think if you are going to build a new mill today you had better look at that. I would say that about 95 per cent of our controls are on PLC. That allows two things. One is the obvious fact that it is easy to make changes during start-up. Even if you spent a lot of time analyzing your mill and going through the process in detail, you are going to have changes at start-up. It is a lot easier for an electrician to sit down at a console and change the operation of the push button or selector switch than it is for him to go and rewire it on a Saturday. The other thing is that it gives some integration between the various machine centers. This is important and something that is often overlooked in a mill. Somebody is operating a drop sort and a problem occurs behind the edger. Well, what do you do? You wave and you bang on the pipes and everything else and you try to get the guy to stop. That is the traditional way. With PLC we have been able to install things such as push buttons for local control where the operator can take over the control of the outfeed of that machine just by pushing a button which gives him full access to most of the controls that he needs. It is a tremendous safety factor and it does integrate the various machine centers together.

The other thing that the fellows came up with was the use of video. I really think that this is the coming thing. Video tape recorders and cameras are not expensive anymore. A lot of the original design of the mill was done not on paper, but standing in front of a blackboard with a video camera recording it. We did it all in-house. We took that information and we used that in all the other phases of the project. We were able to take those video tapes to our designer and he was able to use them as an aid to the design of the mill, especially in the electrical control area. Then we were able to take the videos on into the next steps.

Purchasing

In purchasing the major equipment we actually went into formal contract negotiations. I think this was good. It imposed some discipline on us. It forced us to think about such things as accuracy and productivity guarantees. We didn't always get everything we wanted, but I think that between ourselves and the suppliers a pretty good relationship was established right off. We were serious and we wanted them to give us some performance guarantees. I think more of that kind of discipline is needed in the industry. Again, the decisions were made inhouse, the equipment decisions and subsequent decisions as to modifications and so on.

Design

In the design phase we again tried to do as much in-house as we could. We went to a 'design and build' contract of Industrial Mills and it worked out very well. They have a lot of experience in building sawmills and there are other companies, of course, that do too. Again, in-house approval of drawings and tried to involve the operators and maintenance people where we could in those approvals.

Construction

The construction phase went smoothly and again the main thing was to keep in-house control. We used a number of our tradesmen on the project to handle mechanical and electrical checking.

Training

That brings us to training. I've mentioned the use of the video in defining the mill concept and in the design, and we made extensive use of it in training our people. They were able to watch the same films that the designers watched and the operators were able to understand their consoles. They were able to find out about the operation of each push button. The electricians and millwrights were the same. We got some of our suppliers to also make some videos. Again, nothing fancy, more or less stand in front of the camera with a blackboard or go out to the machine and disassemble it and reassemble it.

We also got involved with a Manpower Adjustment Committee, with the union and the two levels of government. That worked out really well. We didn't spend a lot of time on that, but I think it did set the stage for cooperation, and we also managed to get some money from the Canadian government to assist in our training. Training at Fraser Mills costs about $500,000 before government assistance. We were able to upgrade our tradesmen through hydraulics courses and electronics courses and I'd like to specially mention that we were able to upgrade all of our operators through the Council of Forest Industries' one week course on sawmill practices and grading. All of our operating people have expressed that that was a very valuable course.

The other important factor in the training process is the active involvement of the foremen, or your supervisory people. In other start-ups that I have been involved in there is often a tendency for the suppliers to come in and train the operators while the foreman is off collecting picaroons or time cards or whatever and he doesn't become an expert. I think that our foremen have truly become experts and they are the resource people that our operators can go to who know how to operate the equipment. I think that is absolutely vital.

Start-up

Then you get into start-up. Just a couple of things there. You need to plan realistic production goals. You are not going to achieve 100 per cent the first day. We decided that it would take us about a year to do it and that's about what it took.

Ongoing Operation and Maintenance

Once you get the mill started up and you start getting the production levels up, there is always a tendency to panic, especially with high technology maybe it doesn't work the first couple of months. You say, "maybe we should go back to the old way, and throw in a few operators". But you have to stick with it. That's why it is important to set realistic production goals because even with all the training and the best planning, it does take a while to get on stream. Again, I must emphasize the use of video. If a maintenance person has to come and maintain the strapper and he hasn't done it for a year, he can sit down and watch the film for an hour before and that gives him an idea. He says, "Oh yeh, now I remember how to do it". Don't let suppliers off the hook either. One of the important things when you negotiate those contracts is to negotiate some good, long warranty periods. Suppliers hate to give them to you, but it's important because you don't get to run that machine for a year and a half or so from the time you buy it.

Results

What kind of results did we have. Well, we ended up with a mill that runs very well. It has 19 micro or minicomputers. One thing I should have mentioned too, in that area, is that we really tried to standardize. In those 19 I think there are only three different models. All of the setworks in the mill use the same unit. They were all bought from the same company and they are all hydraulic and whether they are on the carriage or the edger or the resaws, they are all the same and the maintenance people can maintain them quite easily once they become familiar with them. They all use the same basic cards and the same basic approach, although the cylinder sizes are a little different. We have doubled the productivity of the sawmill. We've improved the grade recovery and the volume recovery. We have the flexible product line that we originally planned for. We have highly trained and highly motivated staff, including supervisors, operators and maintenance people. We have also very little staff turnover and very little absenteeism. People just don't seem to get sick anymore and I think that says a lot for the supervision of the mill. I guess about the only result that we haven't yet achieved is to make any money!

In conclusion, I must underline that the fact of life that we on the B.C. coast must face is competition.

The world doesn't need our wood and we as an industry on the coast are really the high-cost supplier in the world today. We can't wait around and expect the customers to bail us out. At this seminar we are looking at the sawmill, but that only represents a fraction of the entire cost of the product. As an industry we also have to look at all parts of the business, all parts of the customer's dollar including forestry, logging, transportation and marketing. Currency exchange rates are really a large factor, but I don't know what we can do about that.

Today's sawmill is more efficient and microelectronics is one of the main reasons. I can hardly wait to see what the future holds. I am really looking forward to coming back here in ten years time and looking at the advances that have been made by then. I am sure our mill, if we don't modernize it continuously, will be obsolete.

Our challenge as managers is to aggressively go after the latest technology, get it installed in our mills and provide training opportunities for our people to allow them to take advantage of this technology. Maybe through that we can compete in the world today.

* * *

SAWSIM and Microelectronics

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The subject of my presentation is SAWSIM and microelectronics. SAWSIM has been, and is being, used to evaluate profit opportunities from process optimizers and is a computer program that simulates the operation of the sawmill. I am going to limit my discussion of microelectronics to its application to process optimizers in sawmills. I am not suggesting that these are necessarily the most important application of microelectronics when the ordinary programmable controller has had an enormous impact.

First I will discuss profits: profits and process optimizers. Process optimizers allow us to increase the value of the product recovered from a given log. They allow us to do it faster and with less labor. Obviously, if we can process logs at the same rate and increase the value of the products developed from each log, both our production rate, in terms of dollars returned, and also volume and value recovery are increased. The result is lower unit cost, more profit, at least in the short run, and the ability to pay higher wages, make an adequate return on investment, maintain competitiveness and survive in the long run.

One of the things I have noticed is that profit improvement comes from a lot of small increments, in terms of the total revenue to a sawmill. The actual increase of, say, putting in a trimmer optimizer is not really dramatic by itself. We are talking about two to three per cent. But when you add all of these two and three per cents up, you are talking about 20 per cent and more. I have noticed that people tend to look for big gains. Well there are big gains, but it is really a matter of accumulating a lot of smaller ones.

By process optimizers, I mean optimizers for edgers, trimmers, log and cant breakdown and log bucking. In these systems the piece is scanned, usually by some electronic device, the sawing solution is computed, the piece is positioned and then transported through some processing machine, such as an edger or trimmer not necessarily in that order. Sometimes a piece is positioned and then it is scanned, and sometimes it is scanned and then it is positioned. There are proven systems in all these areas that are commercially available today at prices that will yield a high rate of return on investment in appropriate applications.

Scanners

Generally, the scanners that are commercially available today will measure the external dimensions and the shape of a piece of wood with varying degrees of accuracy and completeness. Some measure every two feet down the board and some every inch. It is just a matter of the design of the scanner and often the price. They will not generally measure knots and defects. I am referring to the ones you can buy off the shelf today, which you know will work. Systems that will measure and respond to location and size of exposed knots are coming on the market and there are some installed in Scandinavia. A scanning system, for instance, currently offered by Saab in their edger and trimmer optimizers has the ability to record the size and location of knots, but this feature is currently not being used. There are other manufacturers that will probably be offering the same sort of thing.

Practical Application Today

The principal application of process optimizers has been in small log mills, particularly in the B.C. interior and the U.S., especially in the south, and for operator-assist functions in large log mills. However, there are a lot of small knotted, reasonably sound logs that are processed by the B.C. coastal sawmill industry and this will be increasingly so in the future, particularly as they get into second growth. Process optimizers must be used where possible if these mills are to compete. When we are talking about a small log interior mill, just about everything can go through the scanner and you can ignore the knots. On the coast,

mills are going to need much more ingenuity to integrate these things into their operations.

The cost of producing lumber by the interior mills and in the south is coming down all the time and one of the reasons is the use of scanners. They are getting higher recovery and they are reducing their labor costs. If the coastal mills don't respond they are going to be in trouble. They are in trouble now and one of the problems is, of course, that this equipment does require capital investment and money is simply not available at the present time.

Determining If There is a Case for a Trimmer Optimizer

I have used this as an example to start with. It is easy to determine if there is a case for a trimmer optimizer: you simply do a test. You can phone up the vendor to ask him to come and help you, because he probably has some special equipment. He arranges matters so that the operator's decision on a random set of pieces is recorded automatically, but the saws are not actually dropped. You compare the operator's decision with the one that would been taken by the optimizer, assuming completely accurate sawing. You evaluate the vendor's claims as to just how closely his optimizer's performance approaches the theoretical optimium and you work out your return on investment.

Typical overtrim by an operator in a dimension mill is in a range of four to seven per cent by volumes. These figures are from tests reported to me. A trimmer optimizer will give you about one to one and one half per cent overtrim and probably under three to four per cent undertrim. For a trimmer processing, say, 100,000 board feet per shift and an average rough green lumber value of $150 per thousand above chips, this translates to an additional profit of about half a million dollars a year. Typical cost for a trimmer optimizer that is able to process about 60 pieces per minute is around $600,000, plus or minus $100,000 depending on the options you buy. If you want one that will measure lumber thickness with sufficient accuracy for size control, you will probably pay a little bit more. So there is a payback of a little over one year.

You can do a similar type of analysis for a board edger. Again, you do a test; operator efficiencies on such a test typically come out around 80 to 85 per cent. Clearly, since the operator is being tested, he gets better results than he would normally. Scandinavian studies show that in the long term, if you include the end of the shift as well as the beginning, day after day, efficiency is probably down to 70 per cent. A typical edger optimizer can get 95 to 97 per cent recovery depending on the circumstances. Typically an edger optimizer can do 15 to 20 pieces per minute. If they are small pieces, 12 inch maximum width, up around the 20 pieces per minute or more are possible. If they are wide boards, up to 30 inches in width, the figure is probably down to around 15. The limit lies in the positioning mechanism, not in the scanning. Typical cost of an edger optimizer is probably $750,000. That is including an unscrambler, a scanning system and a positioning mechanism so that you can put the board through the edger in the position you have determined it should be sawn. I am not including the cost of the edger itself.

Other Advantages From Edger and Trimmer Optimizers

There are some other advantages of edger and trimmer optimizers. For instance, the scanning and computing sub-system on an edger optimizer can typically handle twice the piece count that can be handled by the board positioning mechanism. One scanning and computing system can be used to feed two edgers, for instance, or it can be used to control a drop sort ahead of the board positioning mechanism. Thus we can route all the boards from a gang edger to an edger optimizer as in Figure 1. We can put all the boards through the scanner and then drop out those that do not need edging. We can drop them out direct to a trimmer or a resaw. Thus we can avoid a drop sort operator. We can get similar results with a trimmer optimizer. In Figure 1, the boards are going through the scanner at, say, 40 pieces per minute maximum, and through the drop sort. The boards that do need edging, probably no more than half, go through the board positioning and then to the edger and then to the trimmer. The boards that don't go through the edger go straight to the trimmer, which I have assumed is a trimmer optimizer. The input to the trimmer might include boards from other sources, some of which may also need edging. The trimmer optimizer can drop out the boards that need edging and send them back to the edger. We will end up with quite a saving in manpower on the mill floor.

The point is, and this as a good example, that you must take a systems approach. These optimizers tend to be regarded as add-ons. You have to integrate the optimizer with the process flow if you are to get maximum advantage from it. At Carroll-Hatch we have gained a lot of experience and with SAWSIM we can predict our piece counts under a variety of conditions. With a coastal type operation, I think you need quite a bit of ingenuity.

Log and Cant Breakdown and Log Bucking

With log and cant breakdown and with log bucking optimizers, it is not nearly so straightforward to estimate the benefits. It is not easy to determine manually what potential product value there is in a log when it is sawn and bucked by alternative

methods. This is where SAWSIM comes in. The principle is simple. We first simulate the process as it is being performed without an optimizer, and then we simulate the process as it would be performed with an optimizer using the information available from a particular scanning system. When you get down to the 'nitty gritty', there are a lot of combinations of machinery and optimizers. So it is not just a question of asking if an optimizer is economical. It is a question of what type of optimizer we should be using and this affects the equipment. Again, it is the systems approach.

The first optimizers tended to be added to Chip-N-Saws. You took a Chip-N-Saw that was already running, put a scanner in front of it, measured the small-end diameter or the diameter eight feet from the butt or whatever, and you immediately got big lift by just getting a better decision from the operator.

But you can actually do more than that. Suppose we are looking at a log and cant breakdown system. If you really want to do it right as opposed to using guesswork, you need to have some information on what an existing system does. The ideal method is to select a random sample, and I have done this several times, and measure the actual shapes of the logs, at say two foot intervals, along their length. This approximates the information that would be available from a scanner. We also mark the centers of the logs at both ends with vertical arrows. We now saw the logs, recording the sets made at each step and the distances of the faces of the center cants from the log centers at each end, as indicated by the arrows.

We also note the angles through which the arrows have turned, a process which is illustrated in Figure 2. The upper diagram shows vertical arrows painted on the log. We can use a straightedge or a string, or it could be a line of sight, and measure the distance to the side of the log. We can do the same thing down to the top of the log and we need to caliper the diameter of the log in both dimensions. From this information we can construct the positions of the center line of the log at any interval we like down the length of the log. Now, if the log went into a four sided chipper canter, the resulting cant might look something like the illustration at the bottom of Figure 2. The log turned, so it didn't go through the machinery the way we measured it. By recording the angle of the arrow, we can determine how much the log turned and we can record the distance of the faces to the center of the log at each end. So, now we can reconstruct how that log was sawn. There may have been side lumber taken off, but we know the thickness of the side lumber and how many pieces.

So we know we can use a program like SAWSIM to reconstruct the actual sawing of the logs, to predict the product outturns from the log measurements and the actual sawing procedures, and we can compare these to the actual outturns that we have recorded. The advantage of SAWSIM of course is that it can handle logs that aren't straight, and most logs aren't. I am not suggesting that most logs are highly crooked, but my experience has been that if you ask people to measure some logs, and I have done this several times, they look at the logs and say, "These logs are straight...but we will measure them anyway." They measure the logs and they find, generally speaking, if they are straight logs I am talking about nice straight spruce typically an inch and a half of sweep on average. An inch and a half of sweep and in a 16 foot log you don't really see that it is there makes a lot of difference to the lumber recovery. If you didn't have that sweep there, instead of making six or six and a half, mills would be making seven or seven and a half as a matter of course. It makes a big difference, particularly on small logs.

Having got our base case what actually happens in the mill, or in a similar mill to the one we want to study we are now in a position to try various other sawing procedures and to compare the results. We like to present the results as projected annual operating statements, assuming the logs in the sample and the operating procedures are representative of a complete year's operation. Figure 3 is an example of a similar analysis. This is a comparison of three different log bucking and sawing methods for different product mixes from the same raw material in a coastal situation. We fed in the results from our bucking and sawing simulations. That is the top part. We then fed in other data such as the log cost, variable cost, fixed cost and so forth. The analysis predicts the logs per shift, the value per log and so forth. At at the bottom we show a projected operating and profit statement with annual net income before tax on the bottom line. We do that for each of the three cases and compare. By this sort of analysis we can show the alternatives and what the actual differences in income at the end of the year would be. We have done this type of analysis for headrigs with a carriage, for Chip-N-Saws and other chipper canter systems and also for log bucking systems.

Examples of SAWSIM Results

Figure 4 shows an example of a log diagram plotted by SAWSIM. This wasn't an actual mill test; this was a theoretical log that was curved. We specified that it would have a 12 inch top with two inches of sweep and be 24 feet long. Now in this particular case it had the horns up. Figure 5 shows the same log rotated through a 45 degrees. I had a friend who used to be a sawyer and he claims that the best way to saw a log is to always put the horns at 45 degrees. He says that you get more recovery that way and you don't hit the guides. I mentioned this to another fellow who had been a sawyer all of his life and he disagreed, saying

that the right way to saw a log is with the horns up and down. In this particular case we took a log that he suggested. We put the horns up and down, and we got a recovery of 6.69. We put the horns at 45 degrees and we got a recovery of 6.98. Actually I think the fellow who disagreed is right. I think that in general you get more recovery if you put the horns up and down. But this was just one log.

Example of Cant Optimization

I want to give an example that pertains to a cant optimizer. In this particular case I used an actual sample of 18 measured logs. The average small-end diameter was nine inches and sawing into one and two inch dimension lumber was simulated. The primary breakdown could be a Chip-N-Saw or the twin band of a chipper-canter-twin. Half or split taper sawing was simulated with the pattern centered horizontally.

The results for three of the logs are shown in Figures 6 through 14 and summarized in Figure 15. The plots were made on a line printer, so they are a bit rudimentary. The big advantage of a printer plot is that it is fast and cheap, but you do get an uneven outline of the log. It is just meant as a guide. Similarly, in some of the plots you will find that there are kerfs between some of the pieces and not between others, and again that is because the printer can only print the characters on certain lines. The actual sawing calculations themselves are accurate.

For each of the measured logs, I developed a straight log with the same small and large end diameter and length and determined the highest valued sawing pattern within the constraints that I had set, which included a minimum bottom set of 5/8 inch.

Figure 6 shows the theoretical optimum for the first log, if the actual shape of the log is not taken into account. In this particular case, the calculated lumber recovery came out at 8.22 which is ridiculous. You would just never get that kind of recovery except for a perfect log, and you notice how the pieces just fit. The next figure shows what would have actually been obtained from that log, the same log except we have used the real shape of it. I used the same bottom set, and what has actually happened is that bottom 2 x 4 went to a reset and yielded a 1 x 4. Similarily the 1 x 4 at the top that was predicted to come out at 12 feet and actually came out at 10 in this example. So our recovery, instead of being 8.22, came out at 5.68 which is more like it. You will also notice that we have got a 2 x 4 plus two 1 x 4's instead of two 2 x 4's and one 1 x 4. So not only has the recovery gone down, but the value of the pieces has gone down.

Then I took the actual log, the way it is in Figure 7, and optimized this bottom set. What happened is that instead of using a 5/8 inch bottom set, we actually increase it to 7/8 inch. Now the bottom 1 x 4 becomes a 2 x 4 and we still get our 14 foot 2 x 4 and because we have pushed the whole thing up we've lost the 1 x 4 at the top. Now our recovery has gone from 5.68 to 5.72, which is not a lot but the value of the products has gone up from $2.65 to $2.86. For this one particular log it isn't a lot, but if it applies to every log on the shift you make a lot of extra money.

What I am getting at here is that in order to calculate this bottom set and get it right, you would have to have a scanner that really does measure the actual shape of the log and you would have to know its position while it is being sawn. If you just have the small end diameter, length and taper, you do not have enough information to determine where that set should be made.

The principal is the same however it is implemented. We could have taken a twin, removed the two side pieces as slabs or used a pair of chipper heads, taken the center cant, turned it on its side and scanned it again in order to determine where this opening face should be. We would now have a cant optimizer. One of the advantages of doing it with a cant optimizer, is that you can also skew the angle of the cant. These things cost you more money and the question is how much more money do you make as a result of doing them.

In this particular log then, choosing the best setting for the cant increases the lumber recovery by one per cent and value recovery in terms of dollars recovered by eight per cent. Of course, the eight per cent is because we make 2 x 4's instead of 1 x 4's.

Results for another log are shown in Figures 9 through 11. In this particular case the theoretical solution in Figure 9 that you might have used in a look-up table, for instance, says that we can get three 2 x 4's from the center cant and a 1 x 4 on either side of this piece. In Figure 10 I have shown the same log with its actual shape, the one that was measured and, of course, the 1 x 4's on either side disappear. They weren't really there. So now we have a four inch center cant, but we still get our three 2 x 4's. Now with the optimizer, we could have discovered that instead of a 2 x 4 in the middle with a six inch centre cant, we could have had a 2 x 6. But the two other pieces would have to be edged to get the 2 x 4's. In this case we gained a 17 per cent increase in volumetric recovery, but a six per cent increase in value recovery. So you got a lot more lumber but it wasn't worth that much more with the prices used.

In Figures 12 through 14 the optimium solution for the theoretical log says you should increase the bottom set up to one and a quarter inches and get a full 2 x 6. So we can get two 2 x 6's and a 2 x 4. Of

course, it is inevitable that what really happens is that if you get a theoretical piece with this much wane on it, it isn't going to make it most of the time. So in this case, the bottom piece was edged back to a 2 x 4. You will note that in Figure 13 we haven't got any wane at all on the bottom piece. Now that's unneccesary. If you had known you couldn't get the 2 x 6 in the first place you would have gone for a 2 x 4. You would have dropped your set or a cant optimizer would have made a similar adjustment. Now, having dropped the set, instead of getting a 1 x 4 at the top, we can get a 2 x 4. In this particular case our lumber recovery has increased by 17 per cent and the value recovery has increased by 12 per cent.

Those were three logs out of an 18 log sample, and what I have done is pick the horror stories. For the 18 logs, an average of four per cent increase in lumber recovery was obtained by taking the absolute best set. We could only have obtained this with a scanner that measures the real shape of the log. There was a four per cent increase in lumber recovery and three per cent in value recovery. If this was a machine that processed, say, 3,000 logs per shift, income would have been increased by about $600,000 a year. This particular one wasn't a real case. I did it as a demonstration, because when I normally do it for a client I cannot talk about the results. But it is an example of the sort of thing that we have done to identify the sort of lumber recovery and product value improvements that can result from a particular approach to optimization. It certainly does depend on the type of scanner, the type of optimizing system proposed and, more importantly, the type of equipment we are trying to optimize.

* * *

EDGER OPTIMIZER WITH AUTOMATIC DROP - SORT

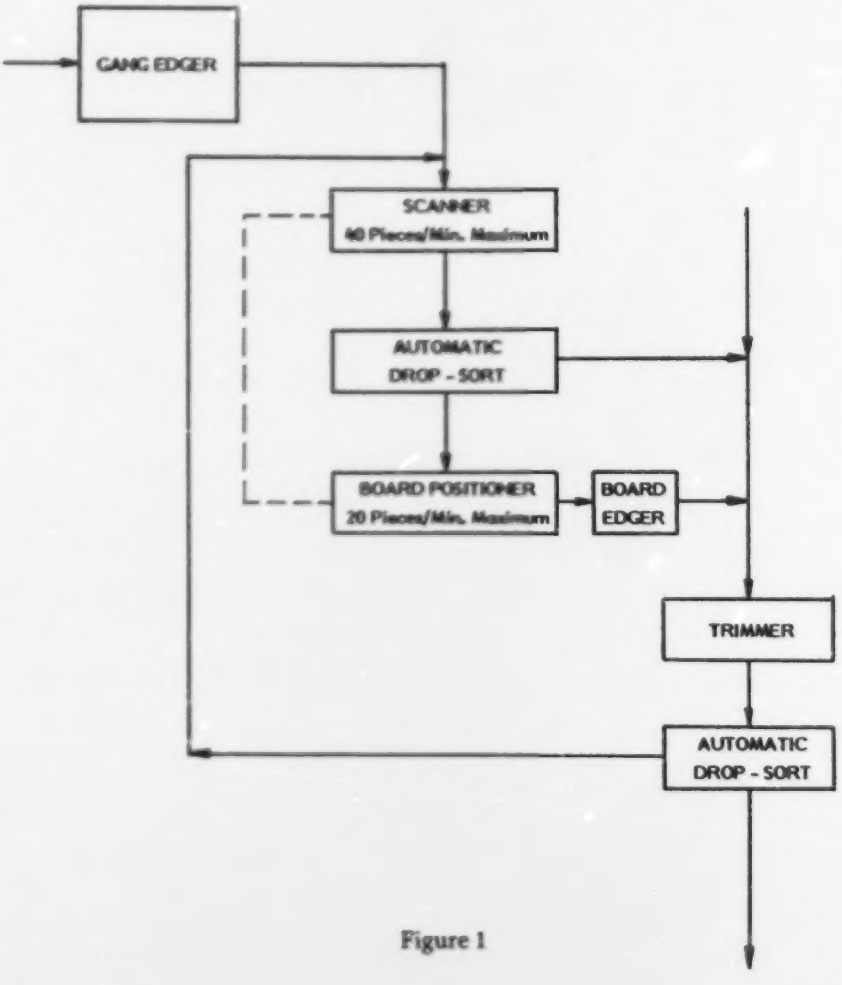


Figure 1

LOG POSITIONING

This diagram shows measurements that can be made on a log and a cant that has been cut from it. These can be used directly by SAWSIM to reconstruct the actual positioning of a log relative to the saws. Vertical lines and an arrow head marking the centers at each end are pointed on the log during initial measurement.

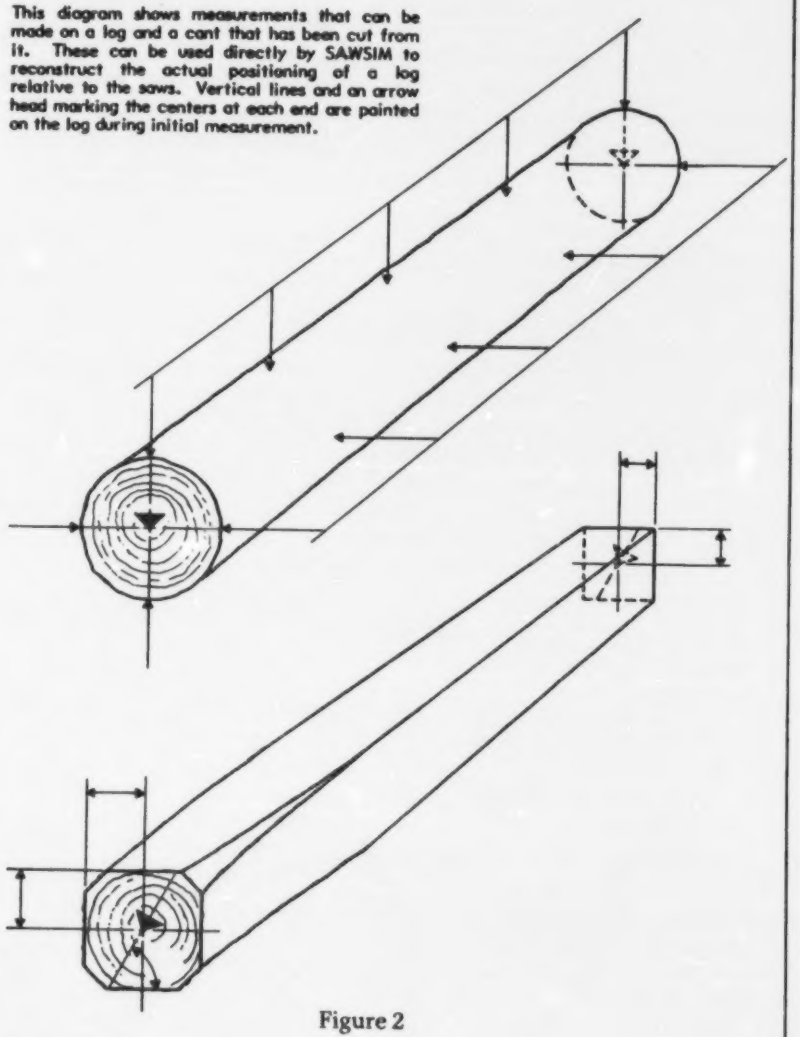


Figure 2

EXAMPLE OF AN ECONOMIC ANALYSIS OF SAWSIM RESULTS

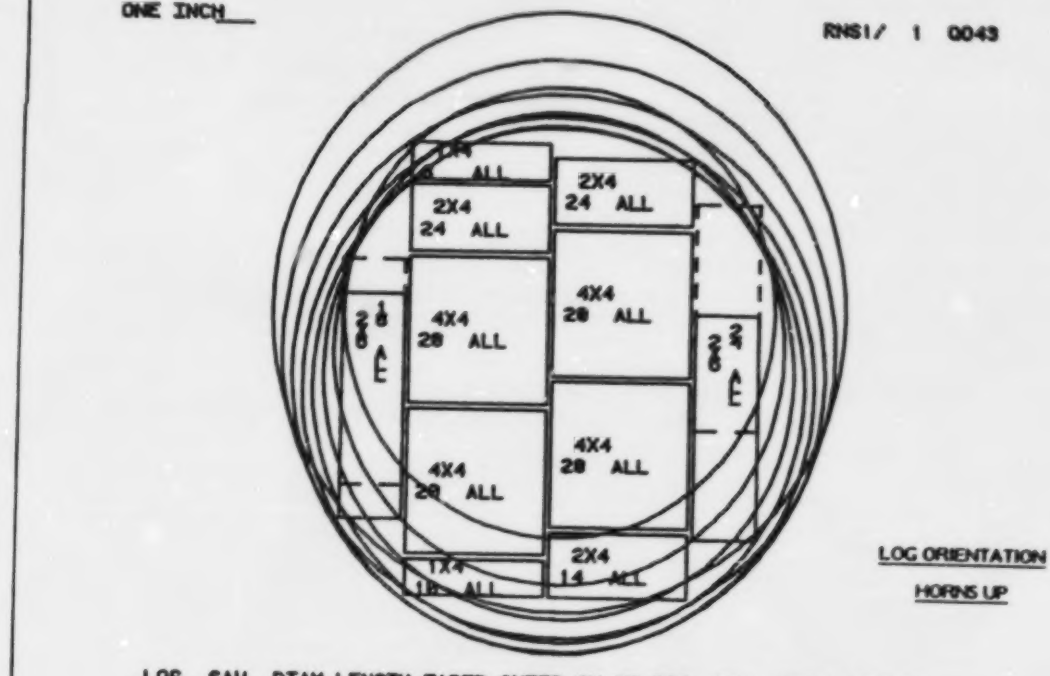
OPERATING AND PROFIT STATEMENT

A. SAWSIM RESULTS PER LOG SAMPLE		CASE 1	CASE 2	CASE 3
Number of logs		26	26	26
Average diameter	inches	11.49	11.63	11.58
Average length	ft.	15.94	14.80	14.80
Log volume	cu.ft.	385.80	385.80	385.80
Lumber volume	fbm	2640.00	3046.00	3161.00
Chip volume	cu.ft.(sme.)	129.10	117.00	113.60
Lumber value	$	572.80	686.60	675.70
Chip value	$	116.20	105.30	102.30
Total byprod. vol.	cu.ft.(sme.)	183.00	187.10	187.80
Total byprod. value	$	122.60	113.70	111.20
Mill time	minutes	3.89	3.99	3.99
OTHER DATA				
Log cost	$/cumit	100	100	100
Variable cost	$/shift	20000	20000	20000
Fixed costs	$/shift	10000	10000	10000
Shift time	minutes	400	400	400
Shifts/year		500	500	500
Chip conversion	cuft.sme/unit	72	72	72
Other byprod.	cuft.sme/unit	80	80	80
ANALYSIS				
Logs/shift		2674	2807	2807
Volume per log	cu.ft.	14.84	13.78	13.78
Lumber recovery	fbm/cu.ft.	6.84	7.90	8.19
Value recovery	$/cumit	206.17	207.44	203.97

B. SAMPLE RESULTS EXPRESSED ON AN ANNUAL BASIS

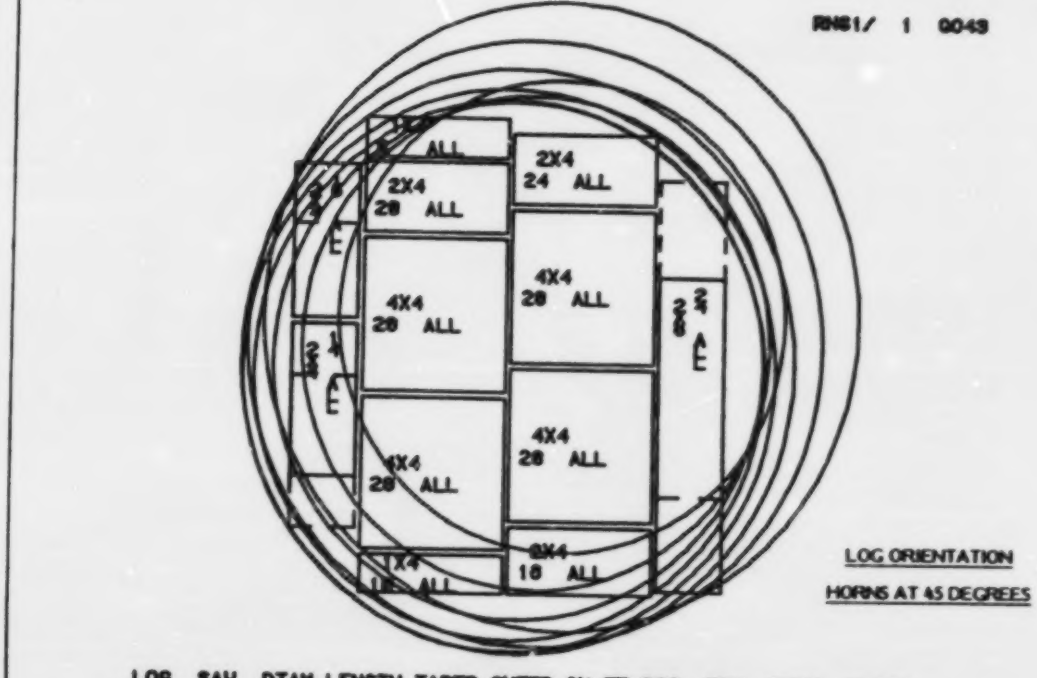
		VOLUME	$/MFBM	$000	VOLUME	$/MFBM	$000	VOLUME	$/MFBM	$000
PRODUCTION										
Lumber	MFbm	135733	253	34591	152682	225	34416	158446	214	33870
Chips	units	92188	44	5974	81454	35	5278	74087	32	5128
Other byprods.	units	34640	2	329	43922	3	421	46491	3	446
Total income			301	40895		263	40115		249	39444
RAW MATERIAL										
Logs	cumits	198355	146	19835	193383	127	19338	193383	122	19338
OPERATING COSTS										
Variable			74	10000		65	10000		63	10000
Fixed			37	5000		33	5000		32	5000
TOTAL COST			257	34835		225	34338		217	34338
NET INCOME BEFORE TAX			45	6059		38	5777		32	5105
CHANGE							-282			-672

Figure 3



LOG IDENT	SAW PATT	DIAM IN.	LENGTH FT	TAPER IN/FT	SWEEP IN	CU.FT SCALE	PCS BR	FBM BR	FBM/ CU.FT.	GROSS $	$/CUNIT
RNS1/1	0043	12.8	24.58	0.163	2.8	27.3	11	182.	6.69	39.48	144.8

Figure 4



LOG IDENT	SAW PATT	DIAM IN.	LENGTH FT	TAPER IN/FT	SWEEP IN	CU.FT SCALE	PCS BR	FBM BR	FBM/ CU.FT.	GROSS $	$/CUNIT
RNS1/1	0043	12.8	24.58	0.163	2.8	27.3	12	199.	6.96	40.58	148.8

Figure 5

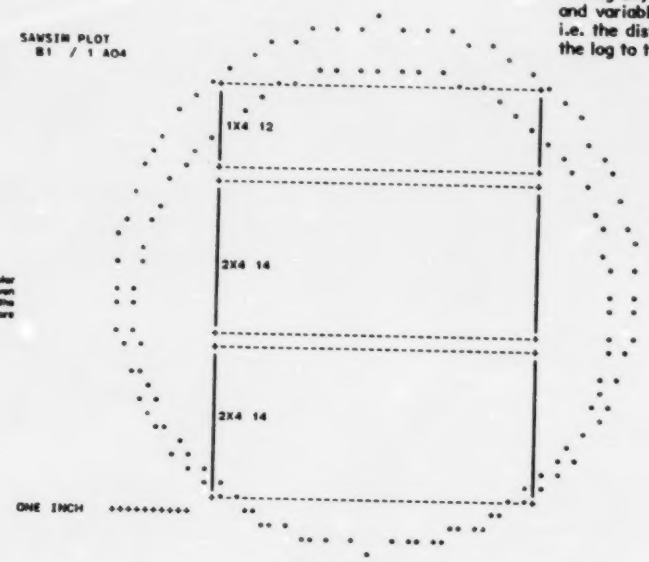
```
<%>

<%     LOG  SAWING    -- OFFSET --    DIA    LEN TAPER --SWEEP--   CUFT PCS  FBM  FBM/ CHIP LUMBER BYPRD  COST  GROSS    $/
<%    IDENT PATTERN    HOR      VER     IN     FT IN/FT EDGE CYL ACTUAL LBR  LBR  CUFT CUFT      $     $     $      $ CUNIT
<%> B1  /1 A04      0.0      0.625  5.69 14.25 0.037  0.0  0.0  2.76   3 22.7  8.22  0.8   3.01  0.48   0.0    3.49 126.6

<%  --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMG    TOT BYPRD  RGH LUM  NET LOG
<%  CUFT     $   CUFT     $   CUFT     $   CUFT     $   CUFT     $     CUFT     VALUE
<%  0.82 0.41    0.28 0.03    0.29 0.03    0.0  0.0    1.40 0.48     1.65      3.52

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRMBACK TRIMMER
<% PASSES         1        1              1       1       3
<% SECONDS        8.      11.             7.      2.      6.
<% $
```

Here is the best theoretical solution for log B1, ignoring the crook, sweep and variable taper. The bottom set, i.e. the distance from the bottom of the log to the bottom face, in 5/8".



Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.

LOG B1

Figure 6

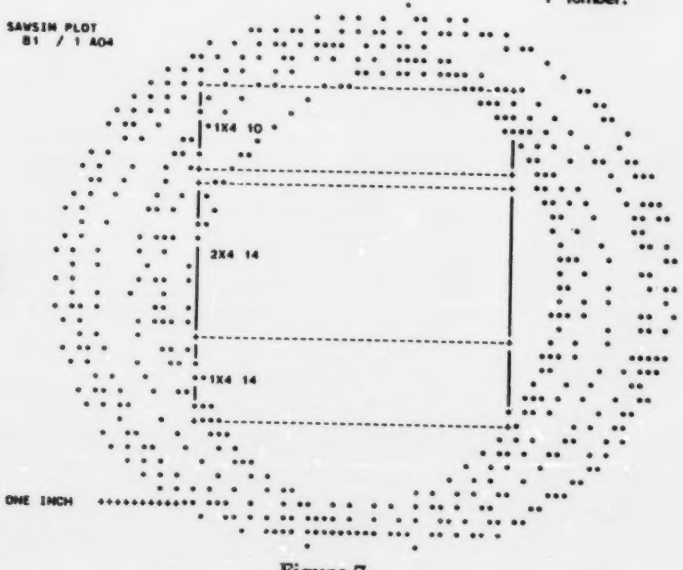
```
<%>

<%     LOG  SAWING    -- OFFSET --    DIA    LEN TAPER --SWEEP--   CUFT PCS  FBM  FBM/ CHIP LUMBER BYPRD  COST  GROSS    $/
<%    IDENT PATTERN    HOR      VER     IN     FT IN/FT EDGE CYL ACTUAL LBR  LBR  CUFT CUFT      $     $     $      $ CUNIT
<%> B1  /1 A04      0.0      0.625  5.69 14.25 0.037  1.3  1.0  2.78   3 15.8  5.68  1.2   1.95  0.69   0.0    2.65  95.0

<%  --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMG    TOT BYPRD  RGH LUM  NET LOG
<%  CUFT     $   CUFT     $   CUFT     $   CUFT     $   CUFT     $     CUFT     VALUE
<%  1.25 0.62    0.39 0.03    0.26 0.03    0.05 0.01    1.84 0.69     1.26      2.69

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRMBACK TRIMMER
<% PASSES         1        1              2       1       3
<% SECONDS        8.      11.             15.     2.      6.
<% $
```

Here is the theoretical solution applied to the actual log. Note that the bottom piece had to be resawn to 1" lumber.



Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.

LOG B1

CASE 2

Figure 7

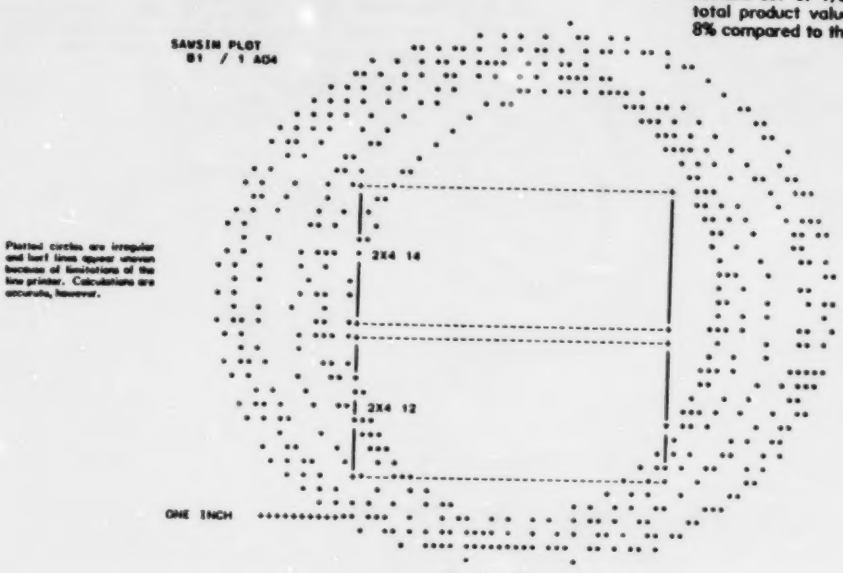
```
<%>

<%     LOG  SAWING    -- OFFSET --    DIA   LEN TAPER --SWEEP--   CUFT PCS  FBM  FBM/ CHIP LUMBER BYPRD  COST  GROSS    $/
<%    IDENT PATTERN    HOR    VER     IN    FT IN/FT EDGE CYL ACTUAL LBR  LBR  CUFT CUFT     $      $      $      $ CUNIT
<%> B1  /1 A04      0.0    0.875  5.69 14.25 0.037  1.3  1.0  2.79   2  15.9  5.72  1.3   2.14   0.72   0.0    2.86 102.7

<%  --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMG    TOT BYPRD  RGH LUM  NET LOG
<%  CUFT    $    CUFT    $    CUFT    $    CUFT    $    CUFT    $     CUFT     VALUE
<%  1.31 0.66    0.29 0.03    0.18 0.02    0.04 0.01    1.83 0.72     1.18      2.82

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRMBACK TRIMMER
<% PASSES         1       1                    1       2
<% SECONDS        8.     11.                   3.      4.
<% $
```

Here is what could have been achieved had a more conservative bottom set of 7/8" been used. The total product value has increased by 8% compared to the previous page.



Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.

LOG B1
CASE 3

Figure 8

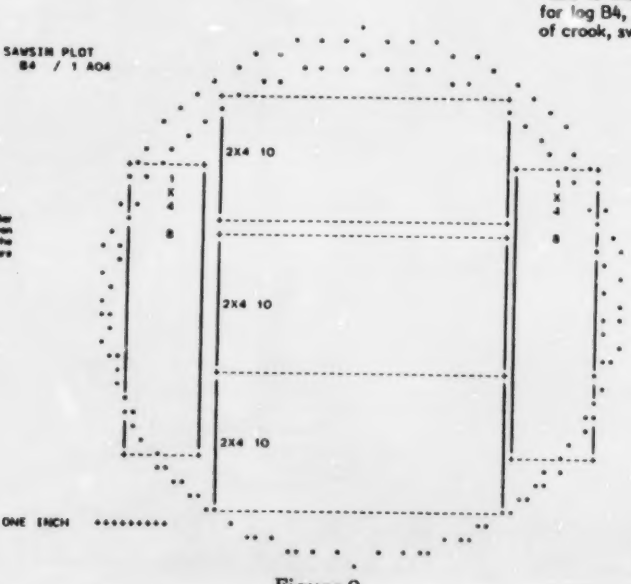
```
<%>

<%     LOG  SAWING    -- OFFSET --    DIA   LEN TAPER --SWEEP--   CUFT PCS  FBM  FBM/ CHIP LUMBER BYPRD  COST  GROSS    $/
<%    IDENT PATTERN    HOR    VER     IN    FT IN/FT EDGE CYL ACTUAL LBR  LBR  CUFT CUFT     $      $      $      $ CUNIT
<%> B4  /1 A04      0.0    0.625  6.55 10.25 0.036  0.0  0.0  2.53   5  25.3 10.01  0.4   3.13   0.28   0.0    3.41 134.9

<%  --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMG    TOT BYPRD  RGH LUM  NET LOG
<%  CUFT    $    CUFT    $    CUFT    $    CUFT    $    CUFT    $     CUFT     VALUE
<%  0.42 0.21    0.26 0.03    0.33 0.04    0.0  0.0    1.01 0.28     1.85      3.43

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRMBACK TRIMMER
<% PASSES         1       1       2       2       5
<% SECONDS        7.     10.     13.      4.     10.
<% $
```

Here is the best theoretical solution for log B4, ignoring the small amount of crook, sweep and variable taper.



Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.

LOG B4
CASE 1

Figure 9

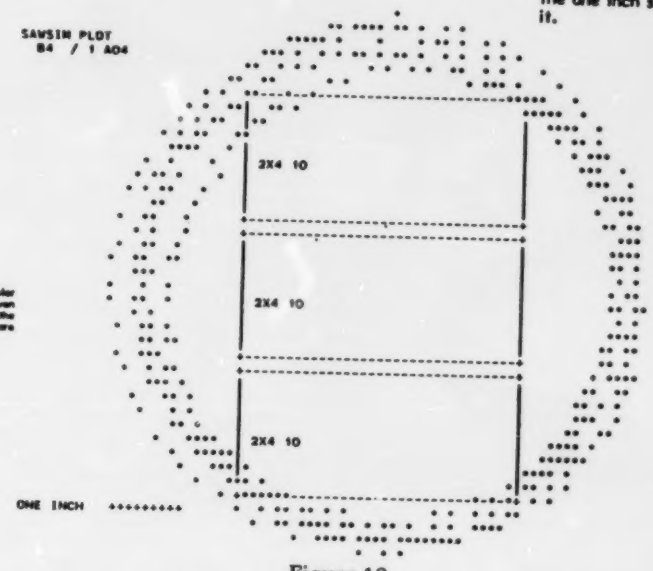
```
<%>

<%     LOG  SAWING   -- OFFSET --   DIA    LEN TAPER --SWEEP--   CUFT PCS   FBM  FBM/ CHIP LUMBER BYPRD  COST   GROSS     $/
<%    IDENT PATTERN    HOR    VER    IN     FT IN/FT EDGE CYL ACTUAL LBR   LBR  CUFT CUFT     $      $      $       $ CUNIT
<%> B4  /1 A04          0.0    0.625  6.55 10.25 0.036  0.5  0.4   2.60   3 17.6  6.78  1.0    2.26   0.57   0.0     2.82 108.6

<%   --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMG    TOT BYPRD   RGH LUM   NET LOG
<%  CUFT     $    CUFT     $    CUFT     $   CUFT     $   CUFT     $     CUFT     VALUE
<%  1.00 0.50     0.26 0.03     0.21 0.02     0.07 0.01     1.54 0.57     1.33      2.88

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRMBACK TRIMMER
<% PASSES         1       1                               3
<% SECONDS      7.       10.                              6.
<% $
```

Here is the theoretical solution applied to the actual log. Note that the one inch side boards did not make it.



Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.

LOG B4
CASE 2

Figure 10

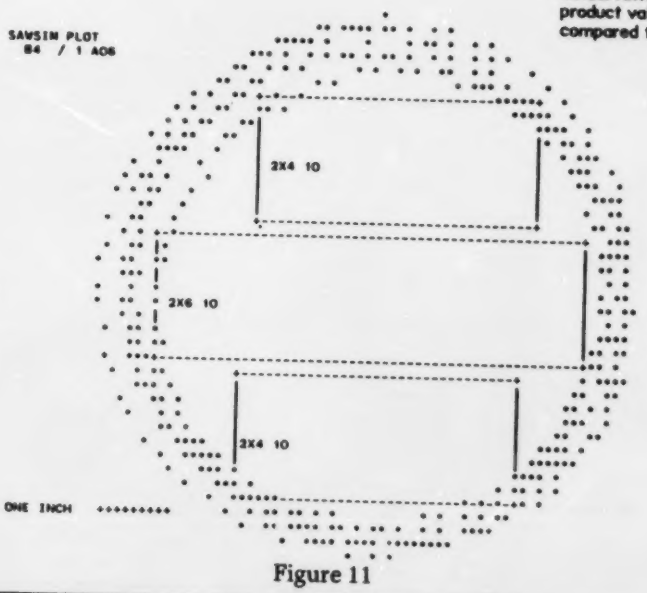
```
<%>

<%     LOG  SAWING   -- OFFSET --   DIA    LEN TAPER --SWEEP--   CUFT PCS   FBM  FBM/ CHIP LUMBER BYPRD  COST   GROSS     $/
<%    IDENT PATTERN    HOR    VER    IN     FT IN/FT EDGE CYL ACTUAL LBR   LBR  CUFT CUFT     $      $      $       $ CUNIT
<%> B4  /1 A06          0.0    0.625  6.55 10.25 0.036  0.5  0.4   2.60   3 30.5  7.90  0.8    2.53   0.48   0.0     2.86 114.7

<%   --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMG    TOT BYPRD   RGH LUM   NET LOG
<%  CUFT     $    CUFT     $    CUFT     $   CUFT     $   CUFT     $     CUFT     VALUE
<%  0.76 0.38     0.26 0.03     0.24 0.03     0.08 0.01     1.34 0.45     1.58      3.01

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRMBACK TRIMMER
<% PASSES         1       1       2               3
<% SECONDS      7.       10.     13.              6.
<% $
```

Here is what could have been achieved with a more conservative approach. The total product value has increased by 6% compared to the previous page.



Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.

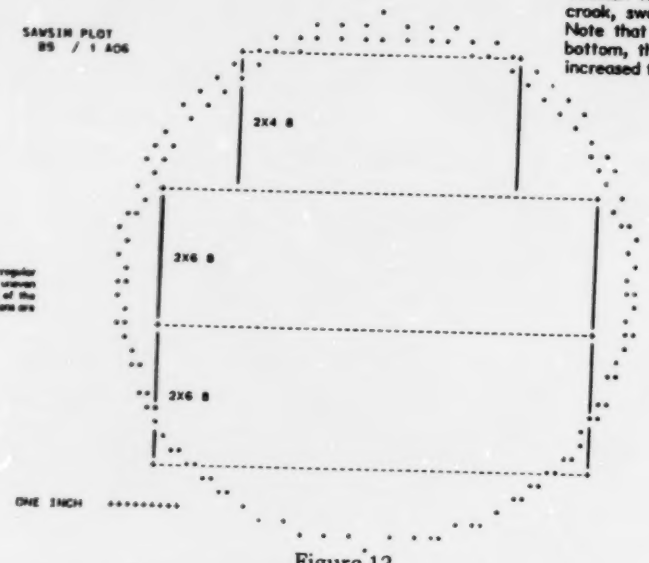
LOG B4
CASE 3

Figure 11

```
<%>
<%     LOG  SAWING    -- OFFSET --    DIA    LEN TAPER --SWEEP--   CUFT PCS   FBM  FBM/ CHIP LUMBER BYPRD  CUST  GROSS    $/
<%    IDENT PATTERN     HOR     VER     IN     FT IN/FT EDGE CYL ACTUAL LBR   LBR  CUFT CUFT     $      $     $      $ CUNIT
<%> B5  /1 A06        0.0     1.125  6.97   8.25 0.029  0.0  0.0   2.26   3 21.3  9.44  0.5   2.63   0.30  0.0    2.93 129.5
                        4
<%  --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMS    TOT BYPRD  RGH LUM  NET LOG
<%  CUFT     $    CUFT     $    CUFT     $   CUFT     $   CUFT     $   CUFT    VALUE
<%  0.49  0.24    0.23  0.03    0.22  0.03   0.0  0.0    0.94  0.30    1.55     2.95

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRIMBACK TRIMMER
<% PASSES         1       1                1                3
<% SECONDS        6.      9.               6.               6.
<% $
```

Here is the best theoretical solution for log B5, ignoring the crook, sweep and variable taper. Note that to get the 2x6 at the bottom, the bottom set has been increased to 1-1/8".


SAWSIN PLOT
B5 / 1 A06
2X4 8
2X6 8
2X6 8
Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.
ONE INCH

LOG B5
CASE 1

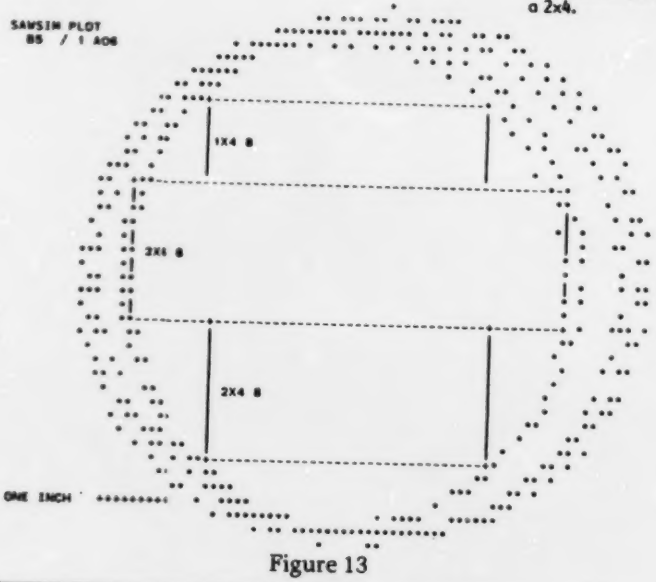
Figure 12

```
<%>
<%     LOG  SAWING    -- OFFSET --    DIA    LEN TAPER --SWEEP--   CUFT PCS   FBM  FBM/ CHIP LUMBER BYPRD  COST  GROSS    $/
<%    IDENT PATTERN     HOR     VER     IN     FT IN/FT EDGE CYL ACTUAL LBR   LBR  CUFT CUFT     $      $     $      $ CUNIT
<%> B5  /1 A06        0.0     1.125  6.97   8.25 0.029  1.0  0.8   2.13   3 12.8  6.02  0.9   1.55   0.49  0.0    2.04  95.8

<%  --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMS    TOT BYPRD  RGH LUM  NET LOG
<%  CUFT     $    CUFT     $    CUFT     $   CUFT     $   CUFT     $   CUFT    VALUE
<%  0.88  0.43    0.21  0.03    0.18  0.02   0.10 0.01    1.34  0.49    1.06     2.06

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRIMBACK TRIMMER
<% PASSES         1       1                2                3
<% SECONDS        6.      9.               12.              6.
<% $
```

Here is the theoretical solution applied to the actual log. Note that the bottom piece had to be edged to a 2x4.


SAWSIN PLOT
B5 / 1 A06
1X4 8
2X6 8
2X4 8
Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.
ONE INCH

LOG B5
CASE 2

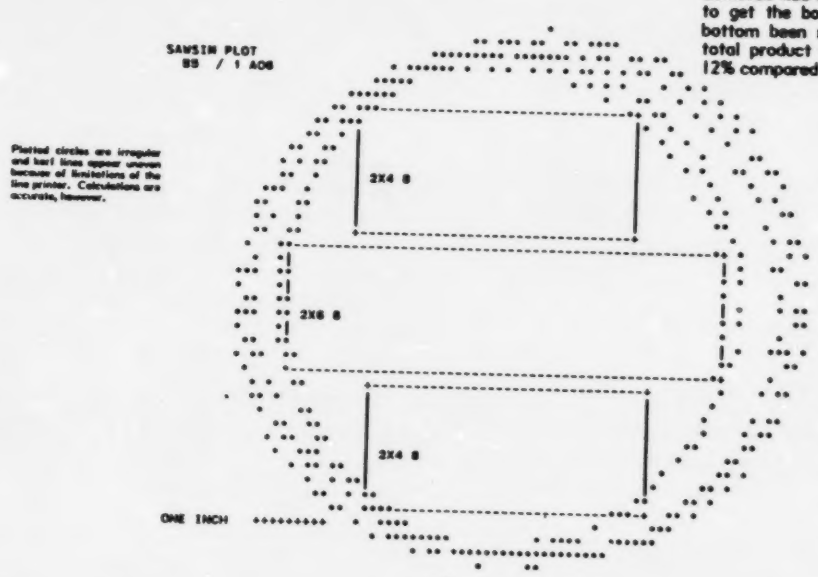
Figure 13

```
<%>
<%     LOG  SAWING    -- OFFSET --    DIA    LEN TAPER --SWEEP--   CUFT PCS   FBM   FBM/ CHIP LUMBER BYPRD  COST   GROSS    $/
<%    IDENT PATTERN     HOR     VER     IN     FT IN/FT EDGE CYL ACTUAL LBR   LBR   CUFT CUFT      $      $      $      $ CUNIT
<%> B5  /1 AOB        0.0     0.625  6.97   8.25 0.029  1.0  0.8   2.13   3 14.9   7.03  0.7    1.88   0.41   0.0    2.29 107.6

<%  --CHIPS--    -SAWDUST-     SHAVINGS    DRY TRIMS    TOT BYPRD   RGH LUM  NET LOG
<%  CUFT     $   CUFT     $   CUFT     $   CUFT     $   CUFT     $     CUFT    VALUE
<%  0.70 0.35    0.22 0.03    0.18 0.02    0.11 0.01    1.21 0.41     1.21     2.33

<%          PRIMARY G-EDGER EDGER-1 EDGER-2 TRIMBACK TRIMMER
<% PASSES         1       1       2                  3
<% SECONDS        6.      9.     12.                 6.
<% $
```

Here is what could have been achieved had no attempt been made to get the bottom 2x6 and had the bottom been reduced to 5/8". The total product value has increased by 12% compared to the previous page.


SAWSIN PLOT
B5 / 1 AOB
Plotted circles are irregular and kerf lines appear uneven because of limitations of the line printer. Calculations are accurate, however.
2X4 B
2X6 B
2X4 B
ONE INCH

LOG B5
CASE 3

Figure 14

Figure 15

Summary of Results for Figures 6 to 14

Log	Lumber Recovery fbm/cuft		Value Recovery $/cunit	
Log Number B1[1]				
A	8.22		126.6	
B	5.68	-31%	95.0	-25%
C	5.72	+ 1%	102.7	+ 8%
Log Number B4[2]				
A	10.01		134.9	
B	6.78	-32%	108.6	-19%
C	7.90	+17%	114.7	+ 6%
Log Number B5[3]				
A	9.44		129.5	
B	6.02	-36%	95.8	-26%
C	7.03	+17%	107.6	+12%
Average (21 logs)[4]				
A	9.41		180.0	
B	7.35	-22%	145.7	-19%
C	7.63	+ 4%	150.2	+ 3%

+$600,000/year
at 3000 logs/shift

[1] Diameter 5.69
Length 14 feet
Taper .037
Sweep 1.3 inch

[2] Diameter 67.55
Length 10 feet
Taper .036
Sweep 0.5 inch

[3] Diameter 6.97
Length 8 feet
Taper .029
Sweep 1.0 inch

[4] Diameter 8.88
Length 16.11
Taper 0.112
Sweep 1.42

Headrigs: Where They Are and Where They Are Going

Randy Parkes
Regional Sales Manager, Kockums Cancar Inc., Surrey, B.C.

The use of microelectronics in the forest industry must be accepted by today's modern sawmiller. Microelectronics themselves have provided us with the tools to assist in analyzing both the need and application of this technology. Mini-computers have allowed us to analyze our sawmill in each critical area of manufacturing, whether it be better knowledge of the resource in the forest, or a better control of inventory of finished products.

Mini-computers used for sawmill simulation have allowed us to discover the vast profit potential in correct sawing solutions for volume or value, the bucking station, the headrig, board edgers, cant gangs, and trimmers, along with the correct positioning of logs, the sorting of rough lumber, savings in drying and planing, and the cost of energy.

We must, however, realize that any simulation will provide us with the ultimate targets, but the actual gains possible will always depend on the level of technology applied or available at the time.

For example:

- Computerized log breakdown simulation can use real time and take three to four minutes for an ultimate solution.
- Sawmill applications require a production need of six to 10 solutions per minute.

Therefore compromises will continue to be made as technology catches up with the need.

My subject is the headrig or primary breakdown machine, where they are and where they are going.

Where They Were

Most sawmills today use the following breakdown machines.

- Two-sided canter (chain infeeds)
- Chip-N-Saw (several configurations)
- Sharp chain systems (canter or bands)
- Conventional carriages

The above machine centers can be enhanced by the addition of some well proven microelectronics such as:

- Programmable controllers to replace relay logic.
- Scanners to overcome inaccuracies of manual sets.
- Linear positioners to replace stacked cylinders.
- Sawyer aids or headrig scanning.

Let's take a short look at the advantages of these items and how they have enhanced the existing primary breakdown.

Programmable controllers

- Replaced relay logic with its inherent maintenance problems.
- Allowed the user to custom design the machine sequencing and control.

Scanners (sawing solutions)

- Have removed the manual sets.
- Have smoothed out the operation of these machines.
- However, they still assume log position, assume log shape, and, in most cases, use a pattern or look-up table configuration (suitable in some applications).

Linear positioners

- Totally programmable (flexibility).
- Accurate (repeatability to .002 inch).
- Fast (speeds up to eight inches per second and faster).
- True example of the evolution of microelectronics in the sawmills (history).

Sawyer's Aids

- Allow pre-stacking of sets (no shims).
- Accurate backstand calculations.

These are true examples of microelectronics being applied to existing primary breakdown systems to improve their productivity.

Where They Are

How have we taken the knowledge provided by computerized sawmill simulation with the advantages of proven microelectronics and applied it to today's generation of primary breakdown systems? In analyzing log breakdown simulation, the most evident in yield (recovery) can be attributed to accurate log positioning and positive log transport.

Log positioning

Because the scanner technology is not yet available to truly identify actual log shape, we still leave this job to the operator and provide him with the proper tools to do the job. For example:

- Feedroll type turners
- Sprocket or stationary turners

This is still a compromise, waiting for technological advancement.

Log scanning

We have advanced to scanning the log after it has been positioned and is being positively transported. This has definitely improved the scanning function, but we are still not identifying log shape, other than some sweep identification. The sawing solutions, because of time constraints, are still of a patterned configuration or a combination of real time and look-up tables.

Because we cannot truly identify log shape and the computer speed is still not applied to allow real time solutions, we continue to compromise in this area.

Positive log transport

This is an area where microelectronics have allowed us to make the greatest advancements. For example:

- Stretch Chip-N-Saw

  Certainly not the ultimate solution, but is a means of identifying log position, compensating for it and at the same time maintaining high production for a relatively low capital cost.

- Full taper infeed

  Again, it is not the ultimate because it has a fixed sawing method full taper; however, it is a very positive transport system which allows us to predict log position and be sure that the log will maintain this position. Again, continues to provide the required production levels at a reasonable capital cost.

- Precision carriages

  These provide us with an excellent transport and positioning device with highly accurate setting and flexible cutting methods; however, throughput is greatly limited and they are only economical where a constant diet of large logs is available

- Side clamp or end-dogging systems

  Either of these systems provides us with the best primary breakdown system available in terms of positioning, scanning, accuracy, and flexibility, but still require manual log positioning. However, at this point the log is clamped by a charger and is positively transported through a dual axis (X Y) scanner. The position in the vertical plane and horizontal plane is identified and the log is positioned for the best open face. A sawing solution, in most cases using a combination of look-up tables and real time, is selected and can vary as to half taper, full taper, center to the pith, or offset. Linear positioners allow us to charge 20 inch diameter logs, 20 feet long at up to 24 inches per second with an accurary of .005 of an inch.

  Due to cycle times within these systems, out throughput is limited to three pieces per minute with a reciprocating end dog to six pieces per minute with a side clamp system. If the average log diameter is large enough, these piece counts will provide the necessary production.

  The side clamp system and end-dog systems are large, sophisticated and expensive; however, they do provide us with the best possible primary breakdown systems available today.

It must be noted that all of these systems:

- Stretch Chip-N-Saw
- Full taper canters
- Precision carriages
- Side clamp feeds
- End-Dogging Systems

use state of the art, scanners, mini-computers, programmable controllers and linear positioners.

Where Are We Going?

To remain profitable in the future, it is required that we recover all of the lumber available in the log and maintain accuracy and high grade wherever possible.

Feed systems

With the concept of the side clamp and the end-dogging, we have provided the basis for mechanical design of the headrig of the future; however, we will have to continue to improve the speed of positioning and decrease cycle times to increase production capacity. This is possible with the development of microelectronics.

Log scanning

This is an area where the greatest advancements must be made. We must be able to identify the actual log and all of its shapes and defects in all planes short of growing square trees. This is the only way of truly optimizing the log.

Log positioning

Once we have identified the actual log shape, the headrig of the future will be required to position this log in an optimum manner. It is evident that robotics will be required in this area.

Sawing solution

The sawing solution will require a real time process to develop maximum recovery from each log in terms of volume or value, boards or cants. This solution will also be required to consider defect as described by the scanners. This system will not be available for six to eight years, but smaller steps can be made to increase recovery.

After we have scanned each and every bit of the log and identified its actual shape, used high technology to solve the breakdown problem in real time, and applied robotics for log positioning, we simply have to accurately transport that log at a rate of 10 to 12 pieces per minute.

The ultimate in log breakdown might never be possible. However, microelectronics has enabled us to establish targets, enabled us to advance towards these goals and will continue to aid us in the persuit of total integrated optimization.

* * *

Saw Tensioning Through Microprocessor Control

Steve Mitten, Vice-President, and Jan Brdicko, Director of Research
CETEC Engineering Co. Inc., Burnaby, B.C.

Steve Mitten:

I would like to begin with a brief introduction on who we are at CETEC, and what we are doing. Jan Brdicko will discuss some of our products in detail.

Most of the principals in CETEC have been involved in the forest industry for quite a few years. Len Mitten is our company president and was managing director of Can-Car for 21 years. He is a professional engineer and holds some of the Chip-N-Saw patents. He has had a long history of involvement with research, including one term on the National Research Council.

Jan Brdicko is our Director of Research at CETEC. He has his doctorate in engineering. He also worked at Can-Car, in charge of their saw research. He is in technical charge of the projects that we will be discussing. I too am an engineer and also worked at Cancar in their service, engineering and research and development departments.

In addition to the people mentioned, we have about 10 electrical and electronic engineers out at our Discovery Park office. We also have a lab/machine shop that allows us to design, build and test our prototypes quite efficiently.

Our number one product is the Smart Saw which is really a guiding system for circular saws. We have been working on it for about three years and it is very close to its completion now. In November we put the prototype unit into MacMillan Bloedel's White Pine mill where we ran it for several weeks. We were successful in reducing the kerf by about 40 per cent. We think that with the production model on which we are working we will be able to reduce kerf by over 50 per cent. In the case of White Pine that means a reduction of over .125 inch. The production model will be ready in approximately two months and we plan to take it back to the mill and run it for a while to prove its reliability.

Another product we have is the rim saw, a replacement for band resaws. It's a new device and can best be described as a circular saw driven by linear induction motors. We've just been working on the rim saw for about a year now and it's got about another six months of development to go. We now have a working prototype and have already cut some lumber with it. It looks very promising. The rim saw, for a 12 inch depth of cut, will be about four feet high, will weigh about 1,000 pounds and will only have one moving part.

Another project we have is what we call the workstation. It's really a robotics or a NC approach to sawmilling. We are working with the National Research Council, several of the large forest companies and several robotics firm. We anticipate that the program will take three years, but we think if it comes through half as well as we anticipate, it is really going to be significant.

The only other service that we have that may be of interest to the forest industry is some of our consulting work. We have a number of programs on our in-house computer that analyze the performance of a saw and the profitability of sawmills. Our customers phone in with saw problems, we plug the information into our computer, and it tells us how we can improve the performance of their saws and how much they can save by going to thinner kerf.

Jan Brdicko:

Steve described briefly what CETEC is, why it was formed, and what we are doing. I will present the technical aspect of the Smart Saw development. I will review why we did it, what were the problems, and

hopefully, although most of you are familiar with circular saws and band saws, it may give you some additional insight into how these things actually work

The basic motivation in CETEC's decision to develop the Smart Saw system was that we kept hearing that it would be a good idea to reduce cutting allowance for circular saws, and how this would result in substantial savings to the mill operators.

Maybe I should define some of these terms. If you look at a cross-section of a typical circular saw, as shown in Figure 1, you can define the nominal tooth width; if you had a rigid saw and perfect guiding system, the cutting allowance would equal the nominal tooth width. Things are complicated by the runout. It is the role of a saw filer to minimize runout. For a rigid saw, runout would have to be added to tooth width. Things get complicated by the fact that a circular saw is an elastic body, and as soon as the saw starts cutting it runs into problems associated with vibration and snaking. So you have to make allowance for this. In addition, one has to make allowance for log transport and its inaccuracies, the vibration of the log itself and a host of other factors. all these effects have to be taken into consideration in calculating the cutting allowance. The question is by how much one can reduce this number and at what cost.

There isn't much we can do about runout. CETEC is a supplier of the saw guiding equipment, and runout minimization is a mill maintenance responsibility. CETEC's Smart Saw system attempts to reduce vibration and snaking and the machine manufacturer could do something about log transport.

We at CETEC have primarily concentrated on reducing the actual tooth width and side clearance. Other people have tried to reduce this by trial and error and by improving control over log movement and, of course, improving saw maintenance. With current saw guiding systems there is only so far one can go in reducing tooth width and the side clearance. Currently most circular saws have fairly large side clearance and that's where we felt the greatest potential was to reduce the cutting allowance. It is not quite as good an idea to reduce the plate thickness because there you start loosing stiffness.

The main reason why saws have a large side clearance is to minimize heat input into the blade. Some clearance is needed for lumber springback and there isn't much anybody can do about that. But if you can do something to the saw which would compensate for the unwanted or undesirable heat influx, then you could reduce the side clearance considerably. This possibility has been pointed out by other researchers in the field. The primary problem the circular saw has is its sensitivity to heat influx into the saw blade, and particularly to the differential heating of the saw while it is cutting.

To get a better feeling for this behavior, imagine taking ordinary circular plate, putting it on the floor, and doing a simple experiment. Take a torch and heat up the blade on the perimeter, and if you heat it enough, it will simply wrinkle. The perimeter appears to get longer because of thermal expansion of the blade, but the middle, which remains cool, won't let it. So what you will see is that the blade perimeter wrinkles. Similarly, when a saw is cutting wood and its teeth are quite dull, it will cause heat input into saw perimeter and the saw will wrinkle. The wrinkle can be quite substantial. We have measured wrinkles as large as two inches on a 36 inch diameter blade. It doesn't take that much heat to do it. We are talking about maybe raising the perimeter temperature by 30 to 50 degrees Celsius. So the blade does not have to be red hot to have these problems.

Let's say you let the blade cool off, and you do another experiment where you just take the torch and heat up the inside of the blade. You will see that at some point the blade, which is initially flat, will buckle or dish. If this happens while you are cutting, it's not very good because you will lose the blade. And again, it doesn't require a large temperature differential for this to happen.

Imagine that you actually perform an experiment where you have control over the temperatures at various radii of the blade, and have the means for applying lateral force at the blade perimeter, as shown in Figure 2. An application of this force causes the blade to deflect some amount, let's call it delta, and you can write the relationship as 'F equals K times delta', where K is a saw blade stiffness. For a stiff blade, the same force will give you a small deflection.

If you have a blade which is not very stiff, the deflection will be large. If you now perform an experiment where you can vary temperature on the radius (temperature is not a function of circumference), and if you were to plot, let's say 'K versus delta T', where the delta T is the temperature difference between the oustide and the inside, you could generate a plot which would look something like the one shown in Figure 3. In other words, for certain temperature differences, let's say the optimum temperature difference, the blade is the stiffest, and that's where you would like to do your cutting. If the blade is stiff, it is also stable. When you cut in this area you benefit twice. The blade doesn't vibrate much and it has maximum stiffness. Where the outside is much warmer than the inside, you have the wrinkling problem. This happens with a stationary blade or a rotating blade it makes no difference. Interesting things happen when the inside temperature is higher than the outside. At some point the stiffness in fact will go negative. That is, the blade wants to buckle by itself. Once it is in a buckled position it will have some stiffness and will probably maintain that, but you cannot operate your circular saw.

So, if you believe everything I've said, and some people don't, then you can simply ask, "why can't this knowledge be put to use?" Wouldn't it be nice if we could come up with a guiding system which would allow us to set at the point where the blade has maximum stiffness. And that is what CETEC set out to do. We spent a lot of money and time, and we are now approaching the point where we have a workable system which actually achieves this objective. The reduction in the cutting allowance achieved with the Smart Saw during our mill tests was substantial. We are currently finishing the development of our production model. The final step will be another mill test at MacMillan Bloedel's White Pine sawmill.

I have explained the physics behind the Smart Saw and will now describe Figure 4 showing a typical Smart Saw system. Our prototype system has two induction heating coils, a displacement probe , a magnet and two temperature sensors. We have more instrumentation on the prototype than we have on the production model. The reason for this is that we have several control programs that work with different hardware. In our first mill test we needed to evaluate each of the different programs.

The function of the induction heating coils is to heat selected areas of the saw. The displacement probe monitors vibration and average saw position. The magnet, when combined with information from the displacement probe, allows us to measure stiffness. The temperature sensors allow us to accurately measure the blade temperature. As only the displacement probe is commercially available, a lot of time was spent developing the hardware.

Now going back to the plot of Figure 3. There are many ways you can attempt to remain in this optimum area. You could identify the optimum temperature difference beforehand and, once you put the saw in the machine, just maintain this particular temperature difference. That is one scheme. Another scheme would involve putting the saw in the machine and performing the stiffness test with the blade. The objective would be to find out what the optimum is and then maintain it. If you could do it every so often, you could have a floating system. Let's say after two hours of cutting this graph may look slightly different. It may have moved over sideways because something has changed which complicates the issue a bit, but you could maintain the optimum temperature difference.

Another scheme would be to measure the blade stiffness and just maintain it at maximum. Or you could use another technique which uses the displacement probe measurement for calculation of the peak-to-peak vibration, or the vibration level of the blade, and use it to change the temperature difference a little bit this way or that, and try to operate at the point where the vibration level is at the minimum. There is a large choice of control schemes, but until you get into the sawmill you don't know which one is the best because in the lab you can make them all work. Basically they all end up with the same result, but, I repeat, you have to go to the sawmill to find out which one works best under actual cutting conditions.

The scheme that worked best during our mill test may be called a 'floating temperature set point'. We continuously check what would be the best temperature difference for the blade and try to maintain it, and change that set point whenever conditions change. Luckily conditions change gradually.

The Smart Saw is a system that can control the temperature difference. But it does more that just get to the maximum point of the stiffness plot; it allows you to take the saw that you started with and reduce its effective cutting allowance significantly. The big gain is in reduced side clearance. The reason why we can do this is because if there is greater friction between the saw and the guide, it simply puts additional heat into the blade. But whatever it is, we can compensate for it by heating with induction coils. We can live with greater friction and thus allow a large reduction in the side clearance.

And that is where things begin to work in your favor; if you study Figure 5 showing what the saw plate actually sees when it is cutting let's say you are cutting this way, lumber is coming that way there is a big, resultant sawing force vector which basically would have a tangential component and the another component perpendicular to the saw. The perpendicular force component is the bad guy of the lot. The other two cause no problem. It is this perpendicular-normal component which causes the deflection of the blade and the snaking, and if this component oscillates it will amplify the vibration of the blade.

It appears that the sawing forces are related to the width of the tooth. In other words, if you have a wide kerf, you obviously need a lot more torque, and hence there is a lot bigger sawing force. You are wasting more wood. If you can reduce the tooth width, then obviously this force is reduced too, and because the force is reduced, one can start reducing the plate thickness because you don't need as thick a plate to carry the now smaller force. When you reduce the plate it is just like rolling a snowball because when you reduce it you can again reduce your tooth width and it allows still thinner plate, etc., but, of course, at some point obviously you run out of improvements.

The process may seem fairly easy, but every item took a long time to figure out and apply to achieve

practical results. It is a very difficult task in itself to package all of the Smart Saw components in a guide arm so that it can function correctly. For one thing, there is a restriction on space. For example, consider an induction coil; you have to make one which is very small and puts out a lot of power and does not heat itself up because you don't want to pipe in all cooling water just to cool the coil. So that basically eliminates conventional coils. We were forced to develop a coil which doesn't heat itself while it is heating the saw. What you get for it is a system that actually works. The user benefits from a smaller cutting allowance, but he also has access to information on what is happening with the blade. The Smart Saw display informs the operator about the state of the saws. During normal operation, the operator may see green lights which say that his saws are okay. The moment one saw cuts through a rock, a red light comes on because the displacement sensor detects this within one revolution. The operator can shut down the machine, or you can shut it down automatically. Either way, that's an improvement. For the first time there is an instrument that indicates what goes on inside the edger. You don't have to wait for a cloud of smoke or some terrible noise to know that something's not quite right, and it's also a good quality check. If a saw filer puts in a saw which is poorly prepared, the operator will know it even before he starts cutting.

For a supervisor, of course, you can provide a video display which can give him all the niceties, but for an operator, lights are probably as much as he wants to see from the Smart Saw.

The rim saw is another of our products and a schematic drawing is shown in Figure 6. That project is roughly half way through its development. It is a difficult project and maybe this is the last time you will ever hear about it. Work on the Smart Saw forces one to ask if there a better way to cut wood. Other researchers have done exotic things like kerfless cutting, laser cutting, etc. That's not something that CETEC elected to try. So we asked ourselves what would be an ideal cutting tool. An ideal cutting tool, we thought, would be a thin rim with teeth on it because it seems like an ideal thing for cutting wood. Now why would you like a thin rim? The reason for that is because if it's thin it doesn't have a thermal problem. If you heat up the rim it simply gets bigger but it won't buckle or wrinkle. It just gets bigger which is nice. We would also like to cut through the saw center because if you cut in the middle you don't have the lumber thrown back or pulled forward. A circular geometry is best because there is equipment available that can be used for maintenance and such geometry is also quite compact.

To preclude back-cutting and to protect the downstream rim edge, the rim center contains a built-in wedge shaped splitter. While you are cutting, the other half would be nicely hiding behind the splitter. That way you don't get the back cutting which is sometimes a problem with circular saws. You have got a nice machine concept now. All you have to do is come up with a bearing which enables the rim to rotate about the stationary center. This design, however, creates a difficult bearing problem. We expected that it would be a major problem, but so far it turned out to be relatively simple. What is also needed is some means of spinning the rim. For this CETEC chose to use linear induction motors and two of these are used for maximum power. The linear induction motors exert a surface traction on the blade through an air gap, which is ideal since you don't want to touch the blade.

People have all kinds of patents where this system is driven mechanically, by little gears, etc., but you cannot go and buy a mechanically driven rim saw because no one could make it work. CETEC's design of the rim saw is unique. We have already cut wood with it, and the results have been most encouraging. What makes the rim saw so unique is that it has only one moving part the rim, which weights approximately 10 pounds. Because the rim has a small surface, it does not generate much noise. Noise comes from large oscillating surface areas. Because the rim doesn't have much mass, it doesn't have much inertia either, so if the rim disintegrates it probably won't cause extensive damage.

* * *

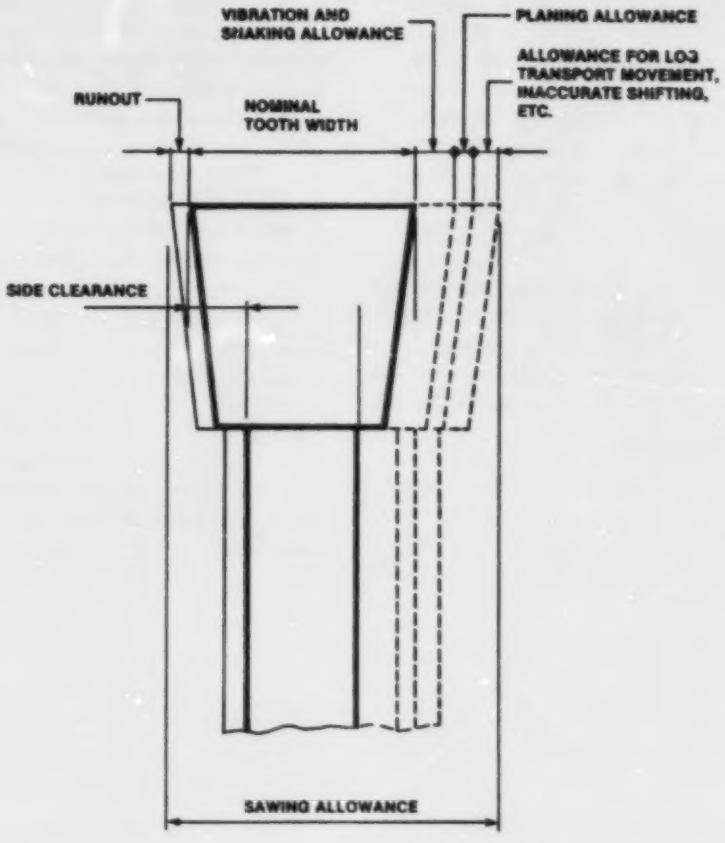


Figure 1. **Cross section of circular saw**

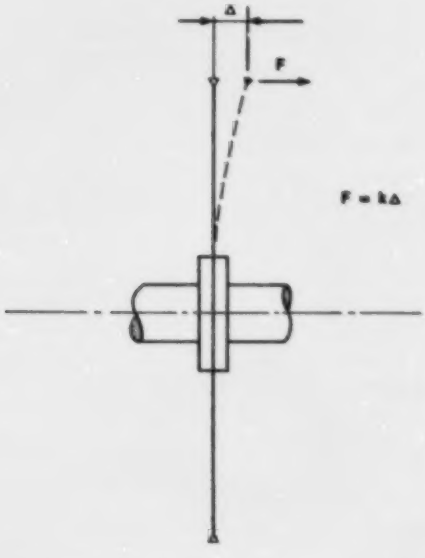


Figure 2. **Stiffness measurement of a circular saw**

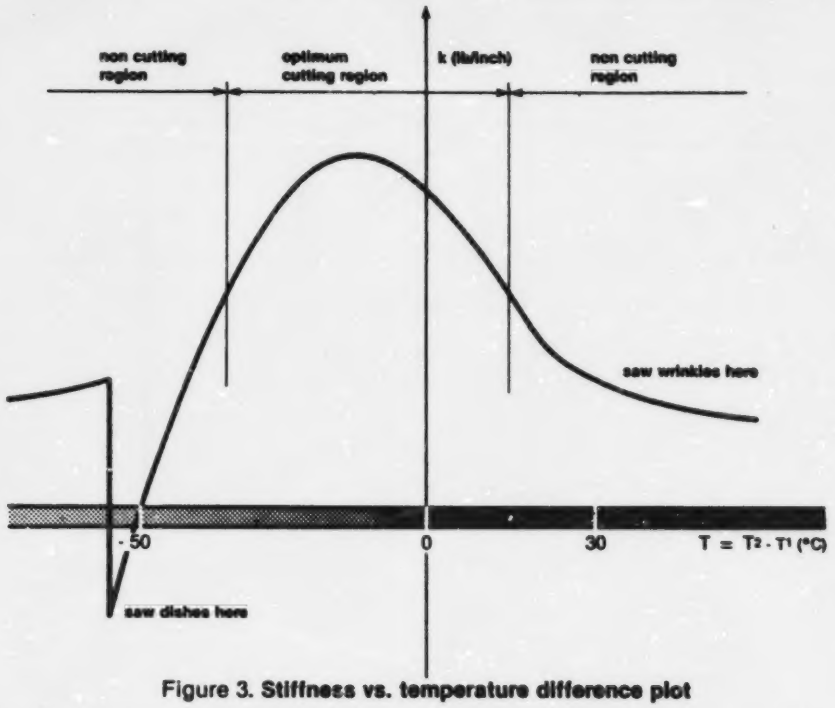
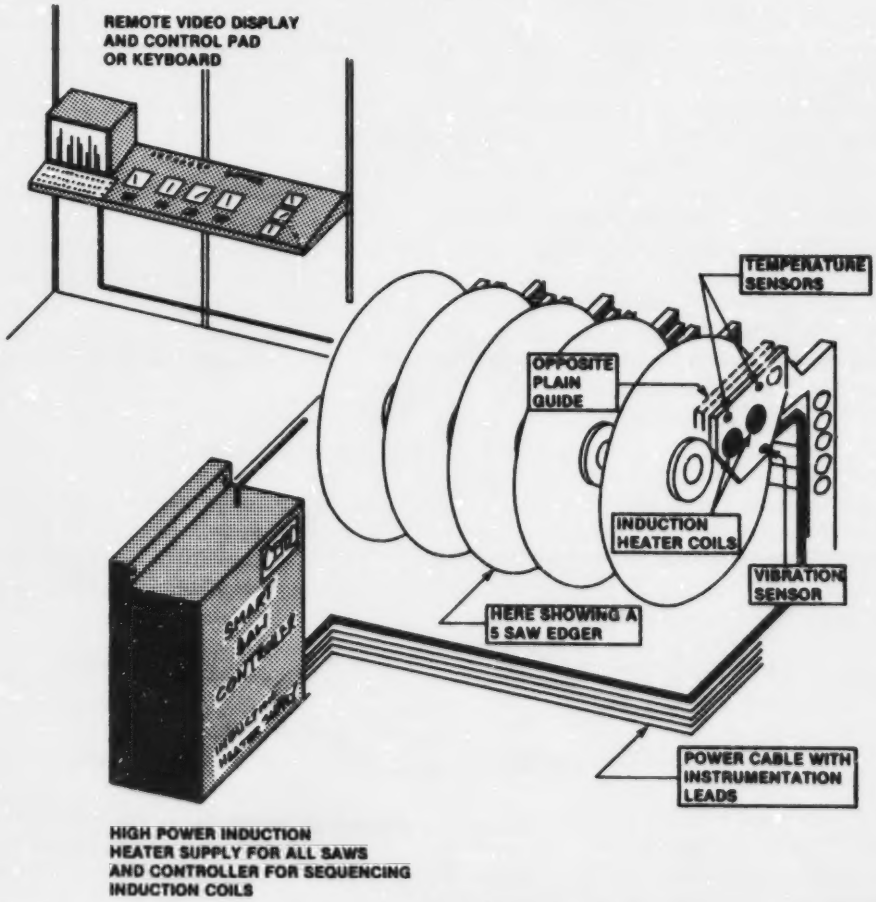


Figure 3. **Stiffness vs. temperature difference plot**

Figure 4. **Schematic of SMART SAW System**


REMOTE VIDEO DISPLAY AND CONTROL PAD OR KEYBOARD
TEMPERATURE SENSORS
OPPOSITE PLAIN GUIDE
INDUCTION HEATER COILS
VIBRATION SENSOR
HERE SHOWING A 5 SAW EDGER
POWER CABLE WITH INSTRUMENTATION LEADS
HIGH POWER INDUCTION HEATER SUPPLY FOR ALL SAWS AND CONTROLLER FOR SEQUENCING INDUCTION COILS

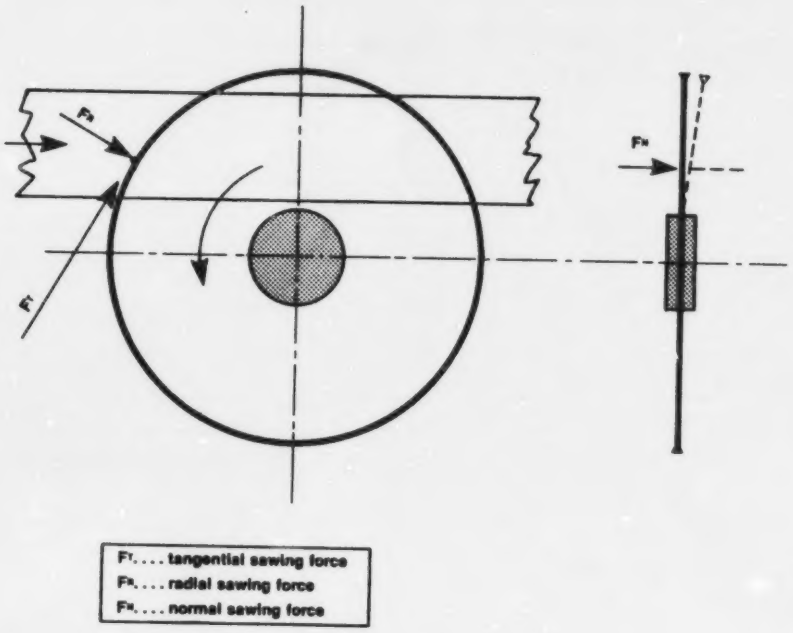


Figure 5. **Resultant sawing forces acting on saw blade**

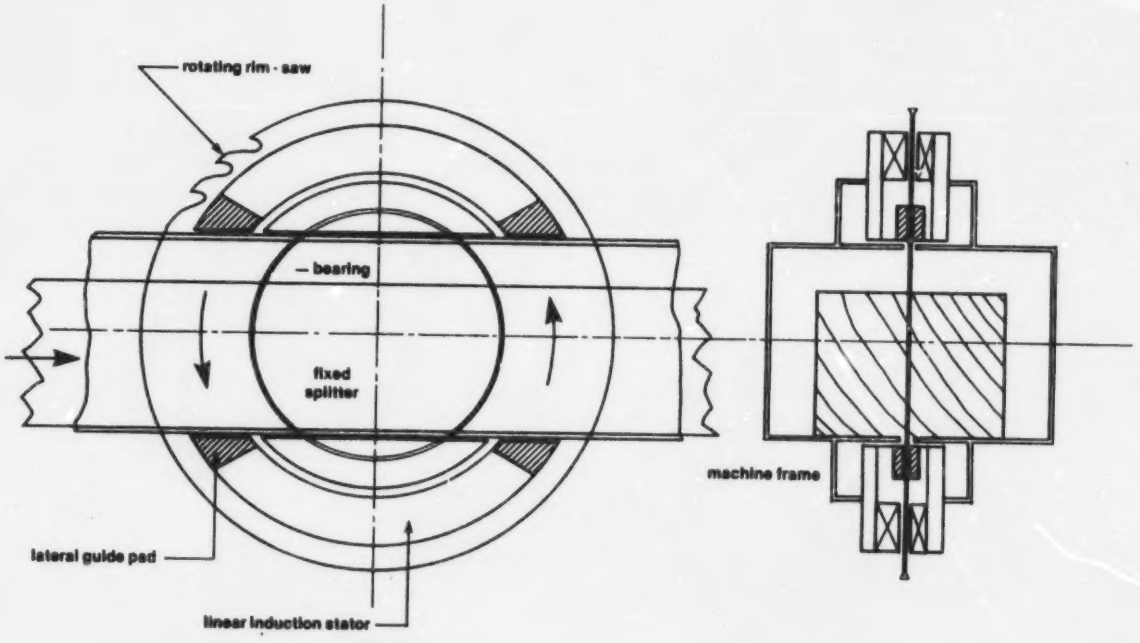


Figure 6. **Schematic drawing of RIMSAW**

Lasers . . . Control Components for the 80's

Warren Thomlinson
President, Lloyd Controls Ltd., Port Coquitlam, B.C.

'Laser' is an acronym derived from the technology which produces the coherent light beam that we know as a laser beam. The word comes from a contraction of the definition Light Amplification by Stimulated Electron Radiation. An electrical power supply excites gas atoms in a sealed gas tube causing light beams to reflect off the two polished ends of the tube. One of the polished ends is not quite as reflective as the other and will allow light to escape once the excitation has increased the light energy to a sufficiently high level to penetrate through the media. As this light exits the laser tube it is focused or directed in a small concentrated stream which, to the naked eye, appears as the ruby red laser that most of us have seen.

The energy levels commonly used in industrial lasers are generally below five milliwatts in other words 5/1000's of a watt or less. Energy levels higher than this can be extremely dangerous to the eyes and to the flesh, and therefore are only used in totally controlled environments. Permanent damage to the eyes can result if a person looks directly into the source of the laser light beam.

The laser light appears very bright and is very concentrated, even though it is at such low energy levels. You may ask why. The reason is that the energy in the light is vibrating or oscillating with the great percentage of its energy all in the same direction, as opposed to non-coherent light which has its energy out in all directions simultaneously.

Because the energy in the laser light beam is so concentrated and has its energy so unidirectionally-oriented, the beam tends to diverge only very gradually as it gets further from the source.

The shape of the laser light dot can be changed into long narrow lines by using suitable refraction and focusing techniques commonly used in conventional optics.

In the sawmill industry laser light lines have been utilized for several years. They have replaced the conventional 'shadow lines' or 'bright white light' from lanterns used as reference lines at edger infeeds in sawmills. Laser light lines have been used for reference at log cut-off saws, on log carriages, on two-saw lumber trimmers and for 'hands-on' manual feeding of edgers, as well as remote handling of cants and boards entering edgers.

In most cases the laser lines are attached to some fixed reference point as used on the cut-off saw and the log carriage and two-saw trimmer. The laser light line coincides with the cutting line that the saw blade will make and hence allows the operator to align the piece he wishes to cut with this reference.

On edgers and canters the laser lines are usually attached to the setworks and will shift the same corresponding distance as the saw shift when the operator adjusts the setworks. The objective is to display the cutting lines on the board or cant prior to passing through the edger, thus allowing the edgerman to make his best possible decision before the board is released into the edger.

The above uses of the laser in industry all relate to man-made uses of the laser beam as a convenient reference tool. Many further advancements have been made which utilize the laser beam as a coherent light source to be used with various video detection systems for the measurement of size and distance of various objects.

Lasers and Computers

Front Lit Log Scanner

By shining laser reference lines on a log and focusing the two video line cameras, the diameter of a log can be measured without going to the expense of making a break in a conveyor and using conventional

shadow detection techniques. The laser beam is reflected onto the log from a parabolic mirror. The electronics receives a signal from a rotating encoder, in addition to data gathered by the video cameras which are focused so that their depth of field precludes objects beyond the area where a log would normally be expected to reside.

The data coming out of the video cameras and the encoder is interpreted by the software of the computer, which then develops information indicating the log diameter and the actual relative position of the log from some reference point. An obvious application in the sawmill is that the sweep of the log can be measured, provided that the orientation of the log is mechanically controlled for the duration of its scan.

Video Laser Shape

By laying down a video line on a board or log and looking at it with a two-dimensional video camera, an image of the laser line can be processed. When coupled with a pulse encoder driven by the transfer mechanism which moves the board or log, a continuous series of digital images or snap shots can be processed for later digital analysis. This digital analysis will determine the shape of the object being processed and allow machines to be adjusted to properly optimize product yield.

Laser Thickness Gauge

The technique of measuring distance to an object by using a laser gauge makes use of the principle of laser beam distance measurement and allows it, through the use of trigonometry and electronics, to accurately measure the thickness of lumber to 5/1000's of an inch while the lumber is moving at high speeds through the scanning zone. The principle here is to cast a laser light reference dot on the surface to be measured and to allow a video line camera to sense the position of the video dot on its array. After calibration, the displacement of the dot on the camera sensor array gives a direct thickness measurement proportional to the displacement of the reference dot within the field of view. (Figure 1)

A pair of such sensors can be operated 'differentially' to measure board thickness, i.e., a non-contacting caliper. Compared to the mechanical thickness sensors in wide use presently, the laser gauge is a substantial improvement. (Figure 2)

By using several such devices in a framework and allowing the lumber to pass through, as is normally used in edger and trimmer optimizers, a series of readings determining the actual board profiles can be taken. This information is important because it can measure to an accuracy much greater than the normal capability of a sawmill worker, primarily due to the shortage of time which does not allow for him to take micrometer or caliper measurements of each piece passing him. (Figure 3)

Edger optimizer systems have been installed where a single differential scanner can scan up to 46 boards per minute, which are then diverted to feed two edger optimizers.

Trimmer Optimizers

Profile information from boards in trimmer transfers is measured by a battery of laser thickness gauges both top and bottom giving true differential thickness measurement and outlining the profile of the board at various intervals down the length of the board. The profile data is collected in the computer memory and later processed to determine the maximum lumber yield available from the raw board.

This evaluation can take on at least two forms. One would maximize the lumber value by comparing the price for various grades and developing the longest highest grade board which would give the highest value for the sale of that piece. The other would develop the highest volumetric recovery. Both of these features are available from the same software by adjusting the lumber grade value parameters in a matrix table made available to the user of the system.

Quality Control

Because the accuracy of the profiling thickness scanner is so good, very detailed reports on quality control of board thickness and board width are readily available. This information enables the sawmiller to pinpoint possible machine malfunctions in secondary breakdown equipment. By exposing problems early, one can avoid mismanufacturing large guantities of lumber and causing tremendous problems with recovery.

It is important for us to point out that the high frequency of measurement and the high resolution enable a statistical calculation to be made to be sure that the quality and size information is meaningful and can be used for the intended purpose.

Alarm limits are adjustable and allow mill personnel to set these to the desired level. Histograms may be kept in hard copy, for comparison, as improvements to mill machines are made, to reflect better on-size sawing.

Summary

The use of lasers in the sawmilling industry has grown quite rapidly from simple applications as guide lines and reference lines to the point where very precise detailed lumber measurements can be made and processed with the aid of computers. The

resulting data, when processed properly in a computer with suitable software, can allow the sawmiller to reach new high levels of automation previously not available.

Future applications of the laser beam as a process control tool will involve the use of the laser optical systems as direct feedback elements in various process control and robotic systems.

* * *

Figure 1

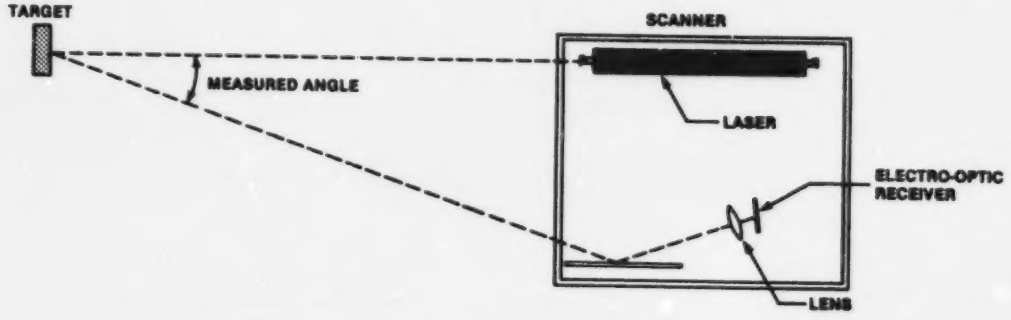


Figure 2

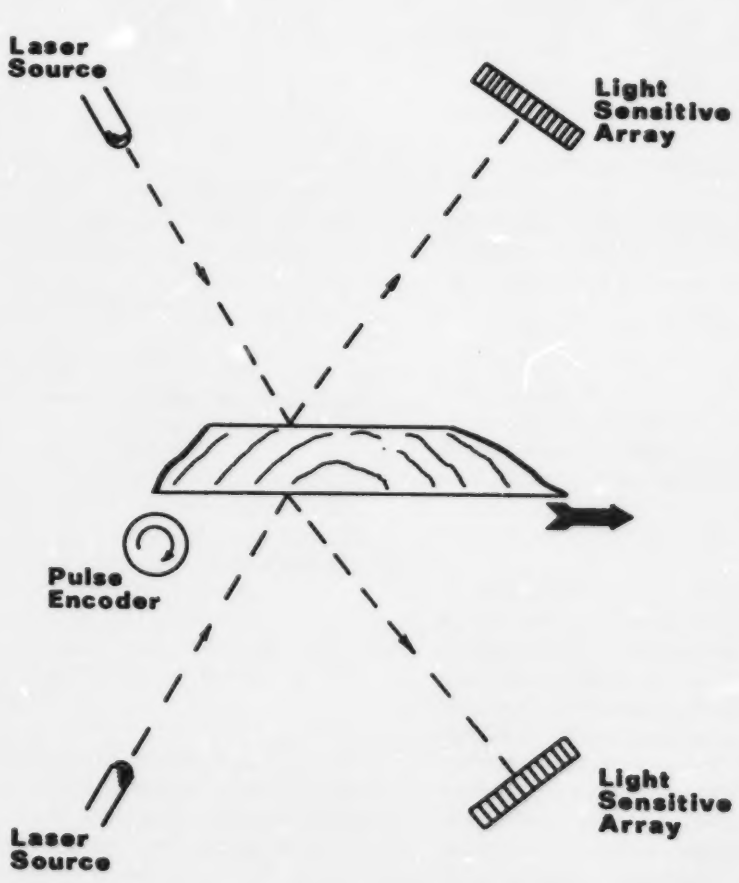
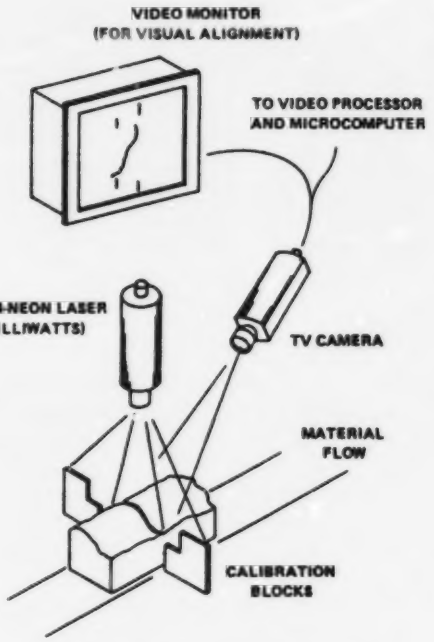


Figure 3

VLS — Video Laser Shape for Three Dimensional Measurements . . .

. . . VLS measures surface contours of objects and material moving along conveyors . . .



VLS – VIDEO-LASER-SHAPE – SCANNING CONCEPT

APPLICATIONS INCLUDE:

- Volume of bulk materials
- Recognition of incomplete or incorrect assemblies . . .
- Length, width, height of packages or boxes
- Sorting by size, shape, etc.

Robotics: What Lies Ahead in Canada

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The 'in' word today is robotics. It refers to an emergent technology which has industrial and commercial applications. Unfortunately the word 'robot' has been misinterpreted and misrepresented by an indiscriminate press, technical charlatans, social reformists and non-technical government representatives.

The myths and tales of modern magic published about the robot have promoted concern about its widespread application. The most quoted myth is surely, "What about all the jobs that will be lost due to the use of robots?" This kind of question has been asked since before the invention of the wheel. Technological advances directed toward making life easier for man and to allow him more time for leisure activies follow the pattern of history.

The initiation of a new technology replaces large numbers of employees, but the emergent technology soon became able to support a larger work force than the old.

When R.S. McLaughlin decided to build 'horseless carriages' instead of buggies he put the manufacturers of buggy whips, etc., out of business, but he initiated an automobile industry that currently employs 250,000 people in Canada. Wholesale robotics conversion at his successor's plants will reduce the work force. But, who will build, maintain and program these robots?

During the industrial revolution in England, John Ludd and his Luddites sought to solve the problems of unemployed weavers by destroying machine looms. Surely we have more intelligent ways than this of dealing with employment problems.

There is a general world recession in business. When the turn around comes, we in Canada will be concerned about our share in the commercial and industrial world. Our nation is in the natural resources business and the service industry. Our manufacturing industry is not large in comparison with that of such countries as Japan, Germany and the U.S.A. We occupy a high and low position the wages paid are about the highest in the world and our productivity per man hour is about the lowest.

We have automated our resource industries and our survival in the area seems assured as long as there are minerals to mine, wheat to harvest, wood to cut and fish to catch. But, in the manufacturing area, if we are to become competitive we must use the industrial robot to the fullest extent.

In the past, with our small home market, our automated but inflexible plants produced large numbers of limited range products. The new concept FMS (Flexible Manufacturing Systems) can deal with multi-product types and low volume production. The change may not be overnight, but robotics can change our own and world markets.

Twenty years ago I was involved in bringing into Canada the new technology of steel extrusion. Our company built a fully automated plant and in three years the products of this plant accounted for ten per cent of the total company sales. At the present time in the plant, technology changes have eroded away the old methods and the extrusion facility now accounts for forty per cent of the business and sixty per cent of the profits. Initially we had considered installing robots they have been around that long! But our local union president suggested that robots would not be

welcome in the plant. The labor union attitude, in general, is quite different today. Perhaps 'some jobs' are better than 'no jobs'.

There are two to three hundred robots in use in Canada at the present time. They are serving well and already helping us to remain competitive. In Windsor, Ontario there are 22 industrial robots in operation in the General Motors transmission plant. The fully automated facility, complete with robot assistance, cost one billion dollars. It produces 4,000 automatic transmissions per day and General Motors will soon have achieved the rehiring of all workers eligible for call back. The General Motors organization also has many more robots in operation in Oshawa, Ontario.

A small spring plant in Chatham, Ontario has a simple mechanical robot to load and unload a steel-heating furnace. It has been in operation for 12 years, has served without fault and has never missed a day. In Orillia, Ontario, a manufacturer who is a world leader in production and sales of his product is using a very sophisticated robot to make toilet seats. Other robots are being used in various other automotive supply industries. A typical welding operation has been 'robotized' in Quebec at Bombardier Ltée. There is also a number of robots at educational institutions. At Centennial College, programs have been initiated to train people to serve privately owned industries which use robots.

There is another public relations myth regarding Japanese industry and the use of robots. Newspaper reports might lead us to believe that we are hopelessly behind in the robotics field. It is alleged that there are 40,000 robots operating in Japanese production factories while we have probably 8-10,000. The problem is one of definition. In Japan anything that replaces human hands is a 'robot'. This would apply to all 'hard automation' in Canada.

Another myth is that of the Japanese 'low price, high quality' image. We have a Canadian steel manufacturer who can beat their prices and their quality anywhere in the world in a selected area of the market. Our national inferiority complex does not serve us well. Let us look at the things we do well and tell the world about them! Class action suits have been launched against Japanese automobiles; they have problems too.

Then there is the myth of Japanese technical superiority. They have taken North American technology and applied it to do a superlative job on their manufactured goods. As a people, they seem to have more incentive and more discipline. But the Japanese are imitators rather than innovators and the 'cutting edge' of high technology still rests in North America and in Europe.

I asked a Japanese engineer with whom I was associated in a world-wide licensing organization, "Why do you work 56 hours a week as a facility manager? I thought you were working a 40 hour week now in Japan?" His answer was, "I am paid for 40 hours per week; however, if I wish to be promoted I must work at least 56 hours per week". It seems that we are playing the same game but by different rules.

While some people decry technological advance, John McCarthy of Stanford University reported in a recent issue of *Omni* that technology advances are very slow. The rate of change between 1880 and 1920 was much faster than that displayed between 1940-1980. He also notes that if the average American worker's productivity has risen four times the 1920 rate, logically four-fifths of the work force should be out of work.

Canada and Canadian industries should move as quickly as possible to adopt industrial robotics wherever feasible. Two thrusts one educational and one promotional can assist in this. Our college is dealing with the first and our government with the second. Through the BILD (Board of Industrial Leadership and Development) grant structures, our college has received excellent financial support. In addition, the board has also sponsored a robotics centre for the promotion of robot application in the broad spectrum of Ontario's manufacturing sector.

Let's define a robot:

"A programmable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks."

This is a definition of the Robot Institute of America, but it does not convey a great deal to most people. Rather more to the point is a sketch of a typical industrial robot showing the essential parts, as shown in Figure 1.

Laws of Robotics

Isaac Asimov, biologist and Professor Emeritus of MIT and author of *I Robot*, set out these rules:

Three Laws of Robotics

- A robot must not harm a human being, nor through inaction allow one to come to harm.
- A robot must always obey human beings, unless that is in conflict with the first law.
- A robot must protect itself from harm, unless that is in conflict with the first or second laws.

Dr. Asimov, whose lively wit has captivated many an audience, also states, "If you could exactly predict what a human being will do, then we would just be extremely complicated robots."

Robots Used in Industry

The general picture for the world market is shown in the chart Table 1 from ASEA, a Swedish robot manufacturuer. A breakdown related to market growth is covered on Table 2.

A question is often asked, "What is an industrial robot?" The definition helps but serves to confuse many. Let's look at some devices known to us and clarify them. (Figure 2)

Are prosthetics robots? No, they are not. They are robotic in the sense that they are to replace human parts which function they hope to imitate as far as it is possible. Some of the devices will likely be used on robots at a later date.

How about exoskeletal devices? These are really an extension of the first, usually used for prothestic purposes.

A very fancy name for manipulators used mainly in atomic energy areas, 'telecherics', are manipulators either hand programmed or computer programmed for limited work in very hazardous areas remote from the operation.

A most unlikely candidate is a locomotion system which does not need wheels. Actions and motions could be related in many ways. How about Canada's Arm? Is it a robot? No, it is not. It is a highly sophisticated single purpose manipulator, but not an industrial robot. It is one of Canada's great design triumphs. It is a great inspiration for all of us involved in the technological field in Canada. One could say the price per unit inhibits its use elsewhere.

Figure 3 will give some idea of the market split between the manufacturers. All significant builders are still North American. It gives one a slight insight as to why at Centennial College we selected robots from Unimation, Cincinnati, Prab and ASEA. We had other reasons since they are type robots in which the main power required is electric, hydraulic, mechanical and pneumatic which encompasses all the systems currently in use.

Man and Robots

Most people wish to make comparisons. Asimov made the excellent observation that working with robots gives you a very interesting perception of just how well designed and constructed a human being is. Absolutely no restrictions in movement, excellent hand-eye coordination, tactile senses excellent, vision marvelous, audio response excellent, limited load capability, capable of rapid decisions, very high computer memory bank, but not so easly programmed.

A robot is not capable of performing all the tasks that a human can achieve. However, robots are able to do jobs better than men and women particularly if they are arduous, heavy and repetitive tasks for long periods in poor environmental conditions.

The specification list (Figure 4) indicates the general specification for a robot, courtesy of Mr. Engleberger's textbook.

'Robonomics'

I guess coining acronyms and new words is acceptable even to our teaching brethren and sisters. The economic lesson is a very simple one indeed. One graph showing the trend in labor cost per hour in industrial plants in North America tells the story (Figure 5).

The other half is a simple pay back analysis (Figure 6). In essence it says the following:

A robot which costs $55,000 installed will return the investment when placed on a working station in a production line about three years in one shift (2.6), one and a quarter to one and a half in two shifts, and likely six to nine months on a three shift operation.

The ultimate consequence of full implementation of industrial robotics and automation is what we call 'automatic or unmanned factories'. The advent of FMS (flexible manufacturing system) integrates the numerically controlled machine tools computer aided design and manufacturing (CAD/CAM) and the numerical control tape with the computer. Such a system is three to five times the cost of the conventional systems but the pay-off is generally worth it.

A Japanese Example: Yamazaki Machinery Works Ltd.

According to *Fortune Magazine*, February 1984 issue, they manufacture parts for machine tools (lathes and machining centers are typical) using 12 daytime workers in a $20 million plant with one watchman at night. In a conventional plant at similar production volume you would require 215 workers, four times as many machines and three months to match three day's production.

According to their management, five years after-tax profit would be $12 x 10^6 which compares with $800,000 for conventional equipment. They are now building a plant in the USA.

Against this strong bid for markets there are a few companies still able to compete with conventional technology. An example is the Briggs and Stratton small engine plant in Wisconsin. They are the world's leading and lowest cost manufacturer of small engines, all through human skill, agility, ingenuity and high productivity. Incentive plans are still used and are part and parcel of a union shop. Workers at the plant earn as much as $30,000 per year. Most people feel they had better 'hedge their bets' and start moving in new directions.

The unmanned factory concept will not solve all our industrial problems. Certainly for many machinery operations it is doing well. Other operations such as foundry work, forge shops, some assembly operations are not easily converted wholly to the automatic factory principle. There is also the question of the volume and scope of your operations particularly if you are a small country.

Some of the consequences of the automatic factory of the future follow as I would view them in various sections of our employment market.

The Factory of the Future

This title asks a question, or many questions, and the answers are, of course, impossible since all is conjecture and depends on a point of view. Each professional expert will have an answer which will address the question quite differently.

Economist - Pressures will tend to make the profit motive less important. Factories will be producing to meet needs rather than catering to luxuries and to satisfy consumer wants. This will affect production volumes, products and incentives to be in business.

Salesman - If only needs are satisfied there appears to be little scope to selling people goods. Sales and marketing arrangements will be unnecessary. Factories of the future would be reduced significantly, and a large commercial segment of industry advertising and sales promotion would disappear.

Design engineer - All products will be functional to fulfil needs. Design will be standardized and selection limited. Long production runs would be more likely. Automatic factories would be a result.

Production engineer - Limited lines more likely and production efficiencies would be high. Limited change required low number of products, high unit production.

Accountant - Excellent control, few product lines, low investment, limited market, low profit potential, question of what return is acceptable morally and financially.

Government - Excellent, help define needs, priorities nationally, barter power needs, tight control on means of production.

Public - Limited opportunity for investment, little opportunity for entrepreneur, little incentive for innovation, limited investment opportunity, managed economy.

In reality automatic factories are a technological success in a world unprepared for the overall consequences. However philosophically interesting, there are no real technogical problems to produce automatic factories.

Automation and transfer systems have been related to single products with major loading costs for change. Very efficient; generally no final automatic product transfer or internal transfer.

Today if we add robots we can do a number of things:

- Pick up and transfer (pick and place).
- Program sequential operations of a common type in space, with excellent repeatability and no fatigue problem.
- Build 'family' type parts with new robotic approach.

Industrial robotics are good buzzwords today. Robots are 25 years old, at least. In today's terms they are expected to allow the recovery of all industrial nations.

Certainly they can help us immensely in keeping competitive in the industrial scene. However, no change will occur as long as production efficiency in the total context changes.

The fact is that our main competitors have systems employing robots now, and unless we can adopt them in numbers and revise our overall targets for production upwards in a significant way, we will only retain our current position of inferiority. However, if we adopt an industrial posture that exceeds production limits of our competitors we can survive. It means a disciplined work force, no absenteeism, commitment, and realistic goals.

Our performance to date has not been encouraging. It's too easy to rely on our material resource industries. The reality is that we can only retain a manufacturing industry if we can produce competitively and there are still Canadian firms that do. Robots can help a great deal, but they do not provide a full solution.

Let's look at robots, what they are, and what they can do for us. But let's remember that they provide

only one more piece in the automated production system.

Finally we get down to education for robotics. It so happens that at Centennial we, through no great planning or deliberation, found ourselves in a perfect situation to get into robotics training in a fairly big way and also very quickly. For almost 20 years the college and the Provincial Institute of Technology have put on a technology course in fluid power engineering. This course is clearly suited for those individuals who aspire to design and build automation systems. The course is ideal background for anyone interested in robotics (Figure 7).

Our staff and students have taken to the new field as ducks to water. Prior to our new grants for equipment the college had about four million dollars invested in laboratory space for hydraulics, pneumatics, electrical equipment, electronics, control systems automation system, interface systems and other science laboratories. The faculty background is excellent, and after acquiring four robots in one year our first graduates are now available and job prospects are good.

Traditionally, our fluid power engineering technician graduates have obtained employment in automation systems design, application, installation and servicing. The robotics area is an excellent 'add on'. The model route for this course is restricted to 60 freshmen and I am happy to report that all places for September 1984 are filled as of this date.

Last September another robotics offering was made and started. The course of study is called Industrial Robotics (Figure 8) and the graduate a robotician. The course is offered as a certificate course on a 52 week mode and is offered for manpower retraining as well as for feepayers. There are three intakes a year with 60 students enrolled at each intake.

The aim of the course is to provide education and training suitable for a technician who will work on the floor with the robot. He or she will be capable of interfacing and living with one to five robots of any basic type and be responsible for keeping it running, scheduled and programmed.

While the graduate would not be expected to do design and development work, he or she could cope with all the normal day-to-day programs. Our feeling is that if robots are to work for us it will be the production floor where the technician is needed. With that philosophy, the following terminal performance objectives in Figure 9 were developed, and the three semester model route is the net result. We had to recast our program from a 36 week mode to the 52 week mode since we quickly realized that there was not enough time to cover the essentials.

Our robot complement is as follows at present:

- 1 Cincinnati Milacron Model T3
- 1 Puma 6 Unimates
- 1 ASEA Pneumatic
- 1 PRAB robot
- 15 Rhino x R2 teaching robots with "Apple E." controls.
- 2 Hero "Heath Kit" robots

All equipment is installed in safe working areas, and all the students will spend laboratory time on all units.

To sum up, it is my contention that robots are here to stay. I feel Canada must move on and quickly. I also believe that our program at Centennial College is an excellent example of education and training for the industrial robotics field.

Industrial Robotics: A Selected Guide

Books

Engelberger, Joseph F. *Robotics in Practice: Management and Applications of Industrial Robots*. Foreword by Isaac Asimov. New York: AMACOM, 1980.

Robots VI Conference Proceedings, March 2-4, 1982, Detroit, Michigan. Dearborn, Mich.: Robotics International, 1982.

Tanner, J.A., ed. *Robotics in the Canadian Manufacturing Industries*. Ottawa: National Research Council Canada, 1982

Tanner, William R., ed. *Industrial Robots*. 2 vols. 2d ed. Dearborn, Mich.: Society of Manufacturing Engineers, 1981.

Warnecke, Hans-Jurgen, and Schraft, Rolf-Dieter, eds. *Industrial Robots: Application Experience*. Bedord, England: I.F.S. Publications, 1982.

Periodicals

Control Engineering. Barrington, Ill.: Technical Publishing. Monthly.

"The Race to the Automatic Factory". *Fortune*. February 21, 1983. Los Angeles: Time Inc. Biweekly.

Hydraulics & Pneumatics. Cleveland: Pentan/IPC Inc. Monthly

"The Robot: A Special Edition". *Omni*. April, 1983. New York: Omni Publications International Ltd. Monthly.

Robotics Age. Peterborough, N.H.: Robotics Age Inc. Bimonthly.

Robotics Today. Dearborn, Mich.: Society of Manufacturing Engineers. Bimonthly.

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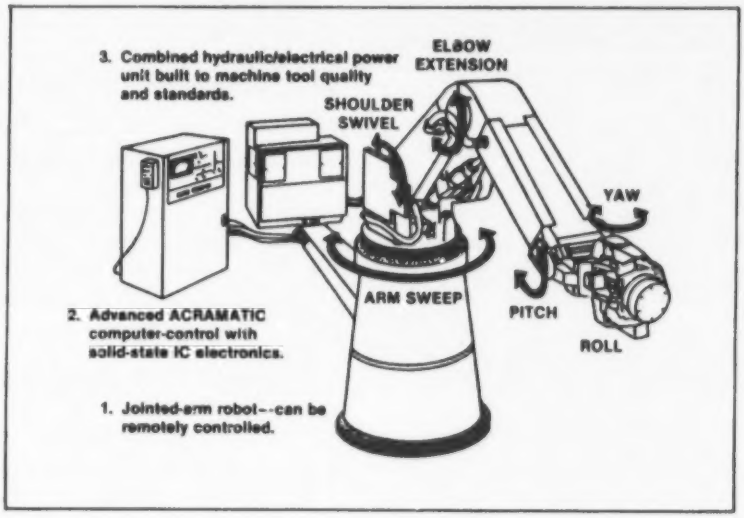


Figure 1

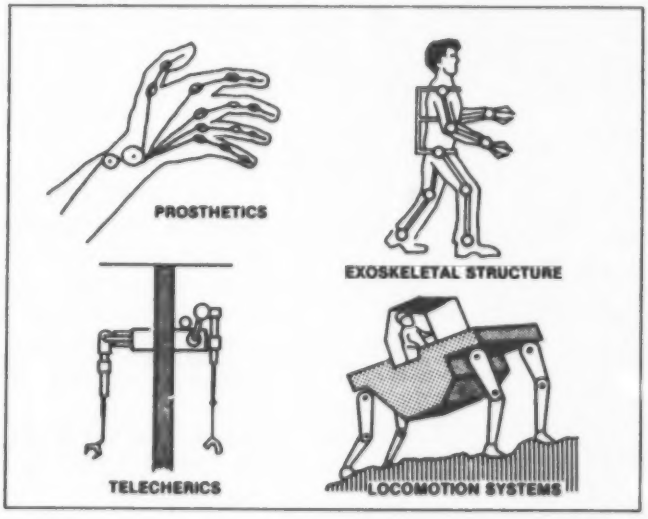


Figure 2

Figure 3

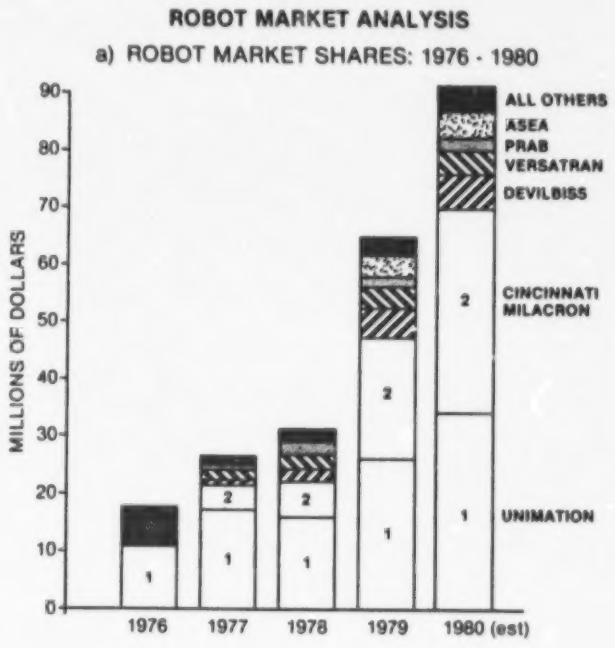


Figure 4

Specification List

1. A hand, capable of gripping and releasing the workpiece.
2. An arm, which can move the hand in three planes.
3. A wrist for the arm, with articulations that allow the hand/wrist assembly to be aimed anywhere in the workspace.
4. Sufficient muscle power to lift a 500 pound (225 kilo) workpiece.
5. Positioning repeatability to 0.3 mm.
6. Manual controls, with which a person can operate all robot limb functions.
7. A built-in memory which can learn the teacher's instructions.
8. Automatic systems which enable the memory to control operations in the absence of the human teacher.
9. A speed of operation which is at least as fast as a person.
10. A library of programs which can be selected at will, allowing the robot to be switched back to operations that it has been taught in the past.
11. Facilities for safety and process interlocks with the plant or machinery that is to be operated.
12. A computer compatible interface.
13. Reliability of at least 400 hours MTBF (Mean Time Between Failure) in the actual working environment.
14. Configuration which allows easy maintenance, with quick access and interchangeability of parts in the event of breakdown, aided by self-diagnostic routines.

Figure 5

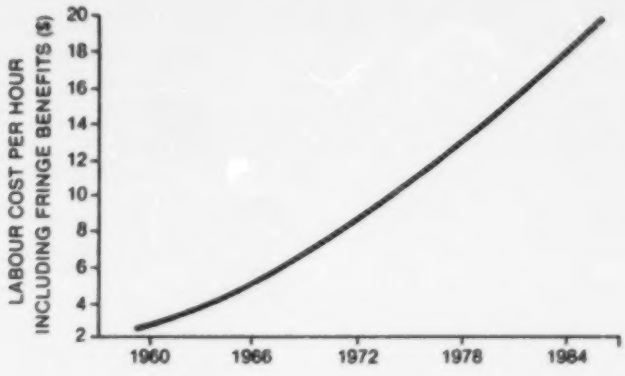


Figure 6

Payback formula

$$P = \frac{I}{L - E}$$

where

P = the payback period, in years

I = the total capital investment required in robot and accessories

L = total annual labor costs replaced by the robot

E = maintenance costs for the robot

Calculation for one shift working

I = $55,000
L = $24,000
E = $ 3,000

Period

$$= \frac{55,000}{24,000 - 3,000}$$ or 2.62 years

For two shift working
1

L becomes $48,000
E rises to 5,000

The payback period reduces to

$$\frac{55,000}{48,000 - 5,000}$$ or 1.28 years

Figure 7

Program: Fluid Power Engineering Technology - Robotics
Major: Technologist - 6 Semesters - 126 Credits Diploma

Freshman Intake

Semester 1 - Fall		EN-101-3	The Art of Making Sense 1
	**	MM-101-3	Mathematics 1
		ME-101-3	Mechanics 1
	**	FP-111-3	Hydraulics 111
	**	FP-112-3	Pneumatics 112
		FP-113-3	Fluid Power Logic
		FP-114-3	Fluid Power Electrics 114
Semester 2 - Winter		EN-102-3	The Art of Making Sense 2
	**	MM-102-3	Mathematics 2
		PC-102-3	Physics
	**	FP-221-3	Hydraulics 221
	**	FP-222-3	Pneumatics 222
		FP-223-3	Fluid Power Measurements 223
		FP-224-3	Symbology and Circuit Design 224
Semester 3 - Fall	**	MM-201-3	Differential Calculus with Analytic Geometry
	**	FP-361-3	Hydraulic Circuits 361
	**	FP-362-3	Pneumatic Circuits 362
		FP-363-3	Programming and Control 363
		FP-364-3	Development and Design Control Project 364
		ME-364-0	(Part 1) Mechanics of Materials
		ME-467-0	(Part 1) Fluid Dynamics
		Elective	College Wide Elective
Semester 4 - Winter	**	MM-306-3	Integral Calculus
	**	FP-461-3	Hydraulic Circuits 461
	**	FP-462-3	Pneumatic Circuits 462
		FP-714-3	Industrial Applications Equipment 714
		FP-468-3	Fluid Power Electronics 468
		ME-364-3	(Part 2) Mechanics of Materials 364
		ME-467-3	(Part 2) Fluid Dynamics 467
		Elective	College Wide Elective
		FP-460-0	Technologist's Technical Report
Semester 5 - Fall	**	MM-309-3	Advanced Calculus
		ME-520-3	Fluid Dynamics 520
	**	FP-569-3	Hydrostatic Drive 569
	**	FP-568-3	Pneumatic Systems Analysis 568
		FP-567-3	F.P. Microprocessor Applications 567
	**	IR-564-3	Robotic Fundamentals 564
		Elective	College Wide Elective
Semester 6 - Winter		MM-310-3	Differential Calculus
		ME-611-3	Interface Mechanisms 611
	**	FP-669-3	Hydraulic Servo Systems 669
	**	FP-669-3	Pneumatic Circuit Analysis 668
	**	IR-664-3	Robotic Applications 664
		FP-664-3	Co-operative Studies in Business & Industry 664
		FP-663-3	Pneumatic Feedback Control 663

** "C" Grade required

Figure 8

Division: Transportation and Industrial Power Technology

Program: Industrial Robotics

Fall 1982

Semester 1		
September 1982	IR-101-0	Fundamentals of Robots
	IR-102-0	Robotic Hydraulics
	IR-103-0	Robotic Pneumatics
	IR-104-0	Robotic Electrics
	IR-105-0	Robtic Physics
	NM-106-0	Math
	NE-104-0	Communications
	Ir-107-0	Metalworking 1
Semester 2	NM-205-0	Mathematics 205
January 1983	NE-204-0	Communications 204
	DR-303-0	Drafting 303
	IR-219-0	Robotic Instrumentation 219
	IR-213-0	Robotic Pneumatics 213
	IR-212-0	Robotic Hydraulics 212
	IR-214-0	Robotic Electronics 214
	IR-215-0	Robotic Physics 215
	IR-218-0	The Language of Robotics 218
	IR-217-0	Machine Practices 217
Semester 3	IR-309-0	Robotic Interfaces
May 1983	IR-301-0	Industrial Robot Applications
	IR-302-0	Robotic Hydraulics 302
	IR-303-0	Robotic Pnematics 303
	IR-304-0	Robotic Electrics 304
	IR-307-0	Robot End Effectors
	IR-306-0	Robot Diagnostics
	IR-308-0	Robot Controls

Figure 9

Terminal Performance Objectives (TPO)

The graduate will be able to:

001 communicate effectively through technical report writing and written and oral presentations.

002 understand all robotic systems and their applications. This will include electrical, hydraulic, pneumatic, and mechanical robots and their associated control and interface mechanisms.

003 be skilled in the use of hand and measuring equipment as required for the maintenance of robotics.

004 to learn and practice preventative maintenance schedules on all types of robots and their associated control and interfacing equipment.

005 trouble shoot industrial robots by learning the diagnostic systems for the various types of robots and the interfacing and control equipment associated with them.

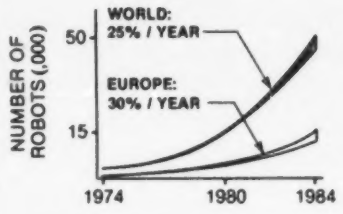
006 learn the basic repair and maintenance procedures involved in the daily operation of the various types of robots.

007 observe and practice at all times, the safety regulations and procedures involved in the operation and repair of the various types of robots and their associated hardware.

Table 1

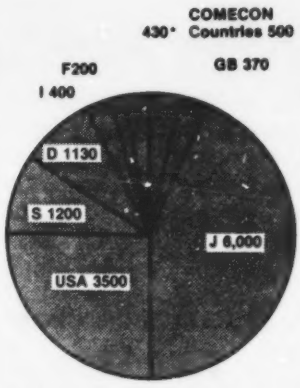
THE INDUSTRIAL ROBOT MARKET

MARKET TRENDS



Source: IFF - IPA University, Stuttgart

WORLD ROBOT POPULATION



*All other European countries including Canada

Source: BRA Survey 1980

APPLICATIONS FORECAST 1980-85

	1980	1985
Spot Welding	500	1300
Arc Welding	400	1600
Painting	150	1100
Machine Tending	450	1100
Cleaning of Castings	50	400
Polishing, Deburring	80	400
Assembly	0	1400
Materials Handling	250	900
Inspection	40	800
Others	80	1200
TOTAL MARKET (excluding Japan)	2000	10000

Table 2

Industrial Robots Market

Item	1973	1978	1985	Annual Growth Rate Past	Future
Robots In Use					
United States	800	3000	50,000	30%	49%
Japan	1500	4000	65,000	22%	49%
West Europe	300	2000	30,000	46%	47%
Other	200	500	5,000	20%	47%
Total	2800	9500	150,000	28%	48%
Robot Shipments					
Units	1000	4000	40,000	32%	39%
000$/Unit	75	50	25	-7.8%	-9.4%
Million $	75	200	1,000	22%	26%
Robots By Type (million $)					
Limited Sequence	8	20	50	20.0%	14%
Pick 'N Place	7	15	75	16.5%	25%
Memory	20	40	125	14.9%	18%
Eye-Hand Coordinate	40	100	300	20.0%	17%
Factory-Intelligent	0	25	450	-	51%

Source: Predicast

Closing Remarks

Tony French
President and CEO, Forintek Canada Corp., Vancouver, B.C.

Wood Supply/Costs

Industry executives in all regions have emphasized their concern with regard to the changing resource. Changes in size and quality of logs were cited as major concerns in maintaining costs at acceptable levels. Wood supply constraints, as Canada reaches the limits of forest industry growth based on the natural forest, were forecast.

No region in the country is better aware of the problem of rising wood costs than the B.C. coastal region. However, this is a concern that has been articulated right across the country. Canada's production costs are projected to increase at a two to three per cent annual real rate over the next decade, while costs are expected to remain relatively stable in Europe and to rise only slightly in the U.S. Higher harvesting costs, lower wood quality and diminishing supplies have been cited in all regions of the country as contributing factors.

Increasing Competition

Industry leaders have expressed concern about Canada's ability to remain a dependable, low cost supplier of wood products to the world. As well as increasing wood costs and limitations of supply, it was pointed out that world wide technological developments were stimulating investment in forest products elsewhere in the world. In terms of conversion efficiency, Canada is the least efficient producer of lumber among the major world suppliers. Industry leaders at each seminar have emphasized that technological change is one of the few remaining options that will help Canada continue to be a low cost supplier of wood products to the world.

Increased Efficiency

Speakers at each of the seminars identified the following areas where recovery improvement opportunities exist:

Harvesting	7.8%
Log trim	2.5%
Saw kerf	2.3%
Size control	3.3%
Headrig	7.5%
Edgers	6.0%
Trimmers	5.0%

Examples abound across the country where the recovery improvement opportunities mentioned have been achieved using advanced technology. However, the industry's own assessment of the percentage of wood being processed with technologically advanced equipment is only 10 per cent.

Increased Awareness/Training

A major reason given by the industry for the apparent slow introduction of conversion efficient equipment is a lack of sufficient quantitative information on the relative costs and benefits to be gained from such equipment. Increased information is required to dispel the mystery associated with the use of microelectronics. This information is required at all levels of management and labor. Of particular value during the seminars was specific mill experiences which dealt with all aspects of the introduction of new technology installation, operation, maintenance and training of personnel. Successful introduction of advanced equipment inevitably takes years of patient effort from both management and labor. To speed up the adoption of microelectronics technology in our industry, information and training are essential. Innovative approaches have been taken by a number of mills. Colleges are designing programs to meet industry needs. Government is placing a priority through their funding programs.

Technological Development

Areas where technological development is required were outlined. In the case of headrigs, developments

in both software and in positioning the log were projected. In the case of positioning, robotics were considered to be necessary. Scanning technology is an area where greatest advancement is required both for logs and boards. Development is required in drying technology. Species sorting is a necessary goal.

Several speakers commented on the deplorable situation where Canada spends less on R & D than any of her major competitors. The U.S. spends four times as much as Canada and Sweden spends three times as much per production unit.

The point has been made repeatedly that in many situations the change to new technology is not resulting in dramatic improvements in profits and is disrupting the labor force, but we must keep matters in focus. We have just come through a terrible economic period and those mills that have made changes have survived better than most. In many cases failure to take this initiative of technological change could have led to total shutdown of obsolete facilities.

It is very clear that all of us in the wood products industry must make a serious commitment to technology change. Increasing wood costs resulting from the transition to second growth timber and an increasingly competitive market place must be offset by improved technology and increased productivity. Labor, management and government must work together if the challenges which have been highlighted in these seminars are to be met.

* * *

Forintek Canada Corp.

Canada's National Wood Products Research Institute

Established in 1979 as a private, non-profit corporation. Forintek is funded from contract research work, industry support, and government grants and contributions. The staff of 200 is about equally divided between its Western Laboratory in Vancouver and its Eastern Laboratory in Ottawa. The corporate office is located at Vancouver, at the Western Laboratory.

A key element in the operation of Forintek is industry involvement in its research programs. This is accomplished through Research Program Committees and a Board of Directors which consist largely of senior representatives from industry, as well as representatives from federal and provincial governments. It is through these forums that a means is established for industry to have strong input into Forintek's operation, program planning and assessment.

By responding to industry's research needs directly, Forintek plays a vital role in solving technical problems and helping the Canadian wood products industry maintain its competitive position in world markets.

"Productivity improvement" is a common objective for industry and government alike. Accordingly, the federal Department of Industry, Trade and Commerce and Regional Economic Expansion is financing a series of seminars addressing productivity improvement through electronic-based technology. Forintek Canada Corp. will be presenting these seminars on behalf of the federal government during 1983 and 1984.

Enquiries relating to Forintek's services and seminars may be directed to:

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